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Vol. VI. Philadelphia, May, 1902. No. 4.

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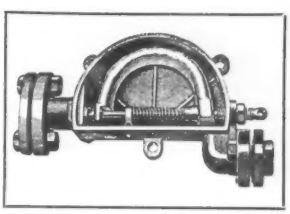

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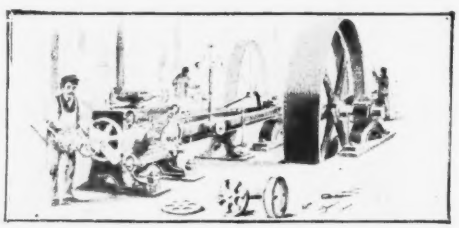

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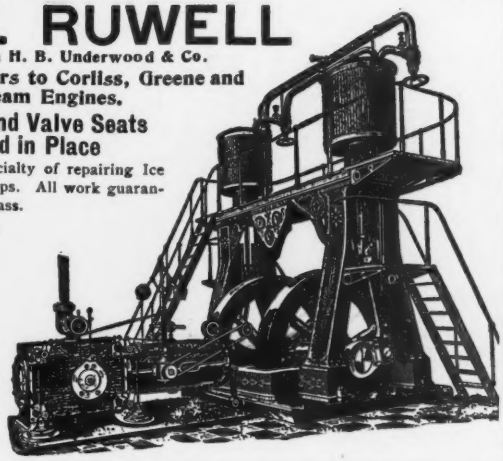

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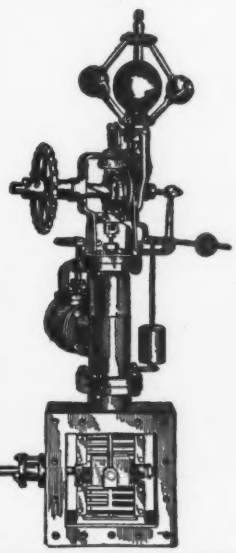

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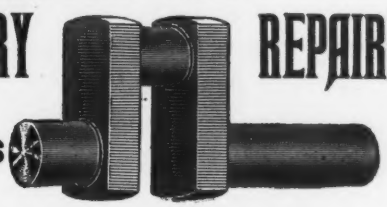

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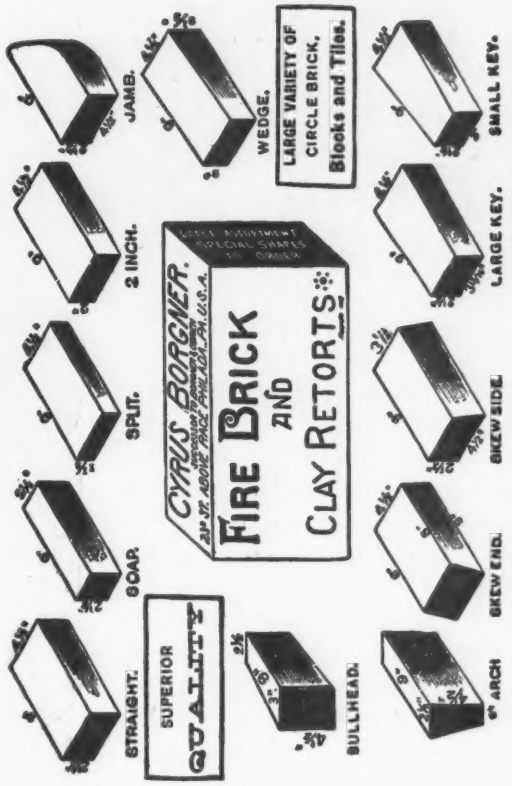

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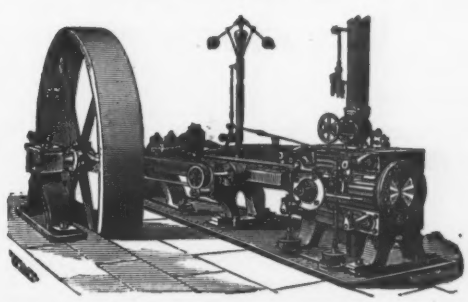

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The Practical Engineer

THE
OFFICIAL ORGAN
OF THE
AMERICAN ORDER
OF STEAM ENGINEERS

Devoted to the Interests of Stationary Engineers.

VOL. VI. PHILADELPHIA, MAY, 1902 No. 4

Organization—Its Elements of Success.

It is with pleasure that we note the recent advancement of the American Order of Steam Engineers. During the past month the Order has increased by the addition of three new Councils, the ones in Pittsburg and Germantown having unusually large memberships to start with, and giving promise of successful futures.

The new members will find in the American Order all of those features that will tend to their educational elevation with its contingent advantages, and they will also find that in associating themselves with the American Order, that they have placed themselves in a position to assist in the purging and placing upon a higher plane the standard of their life's vocation. In addition to the educational features of the Order the new members will be benefitted by the fraternal features of the organization, a feature which will undoubtedly appeal to all, as it enables each to assist the other in ways other than that of mere words.

Time and again we meet the pessimist who is constantly lamenting the failure of the engineer of to-day, compared to the success of the man of that calling of years gone by. He will quote you: "In the good old days, when everyone who expected to be an engineer had to serve his time in the shop, and be versed in all things from scraping a joint to putting on soft patches. Those were great days and the engineer was not bothered by cube foot or calorimeters. All he had to do was to put on overalls and work." But right here let us say that the world has moved along since then, to-day we are in the beginning of the Twentieth Century, and while our pessimist somehow manages to hang on, and maybe occasionally creeps to the front for a time, he don't like the pace, it's too strenuous for him.

The so-called good old days, however, have gone forever in the ever-changing evolution of things, and what would have constituted a good engineer then would and could not answer now. Thus we can see and appreciate the many and varied advantages of the engineers' organization. Centralization of strength is one of the features of this century; without unity in thought and action in these days we become at once outclassed.

From the ranks of manual workers, the engineer has gradually advanced, until to-day his calling is in every sense a professional one. Instead of merely stopping and starting an engine, and doing odds and ends of repairing, he is expected to handle a great variety of machinery, and understand it both theoretically and practically in all its branches. Aside from this he must keep abreast of the times and be at all times in constant touch with any and all of the constantly improving conditions and appliances of the profession.

Here, then, again is he benefitted by the organization, for be he ever so dull he will acquire a multiplicity of new thoughts and ideas analogous to his profession through his associations of the lodge room.

And so we could go on and on enumerating many features beneficial to the engineering class through affiliation with the American Order of Steam Engineers. Suffice it for us to say that those new members will find within it much to commend.

The pessimist may have his lament and kick about how much an engineer has to know and do these days, but we feel safe in saying that there are but few who would care to exchange the present status of the profession for that of the past, and few will deny that the engineers' organizations have contributed very largely, both morally and intellectually, in affecting the changed conditions.

+ + +

Ohio Engineers' License Troubles.

Recent events in connection with the Ohio State License Law, or laws, have assumed somewhat of a theatrical phase, which are, to say the least, interesting. On March 1, 1900, the Ohio

legislature passed a bill requiring all engineers in the State operating plants of 35 horse-power or more to be licensed. All plants of less than 35 horse-power and all engineers who had been employed in the State continuously for a period of three years next prior to the passage of the law were exempt.

This bill, which was known as the Roberts' Law, became operative May 1, 1900, and continued in effect until quite recently, when it was declared unconstitutional by the Circuit Court of Butler County. This Court exercises jurisdiction over five counties, and the decision was looked upon as practically a death blow to the law. But the friends of the law, who were said to be chiefly the inspectors and others holding positions created by the law, nothing daunted, immediately appealed the case to the Supreme Court of the State, and at once set about procuring the passage of a new bill, with the result that on March 13, last a bill known as the Pollock Law, was passed.

Inasmuch as the Pollock Law repeals the Roberts Law, the Supreme Court thought to drop the appeal from the Circuit Court's decision on the Roberts Law, but the prosecuting attorney of Butler County answered that the Pollock Law contained the same infirmities which the Roberts Law contained, and requested to have it heard and decided, so as to determine whether there was anything unconstitutional in that character of legislature. Accordingly the matter was taken up by the Supreme Court and their decision has just been handed down, affirming the decision of the Circuit Court.

This apparently leaves the Pollock Law open to successful attack by its opponents, and incidently reflects discredit upon the framers of that law, who, judging from the incomplete information at our command, were more eager to avoid opposition to their measure than to protect the interests of either engineers, owners of steam plants, or the public.

A large number of Ohio engineers were dissatisfied with the Roberts Law, and many will doubtless be equally dissatisfied with the Pollock Law, but it remains to be seen whether they will carry the matter into the courts again or rest content. In view of past events the latter course seems improbable, and it will not be surprising if the next year is productive of as much new history in this line in Ohio as has the past, in any case the developments are likely to be worth recording.

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The Relation of Engineers to Building Construction.

It is time that architects should recognize the fact that an engine and boiler room is entitled to proper space, and also in alloting this space that it is their duty to consult, and be governed, by an engineer of experience in such matters.

Just why more attention is not given to this point by the designers of our large buildings is very hard to say. Surely it is in the engine room that the fundamental maintenance of the building is to be looked for, yet how little attention is given to the manner of placing the machinery, etc.

Probably the most disagreeable feature of an engineer's existence in the larger cities is due to the placing of the power plant. From a superficial view of some of the magnificent structures we may see upon every side it is easy to become enraptured with and lost in admiration of the genius who planned them. Every conceivable necessity seems to have been adequately provided for in the matter of convenience and comfort for the tenant.

To the ordinary observer they are all that is perfect, but the visiting engineer will reserve his decision concerning the genius of the conceiver until he has seen below the street floors. In nine cases out of ten the further down he goes the less respect he will have for the man who locates the power plant (the very essence of the building's existence) in a sub-department of a sub-cellar.

In the majority of cases the entire machinery will be found in the least accessible part of the cellar, engines and generators will be found sandwiched in between arch-ways and foundation piers of the building, pumps placed so that tortuous lines of pipe are necessary to reach the elevators, boilers so arranged that to inspect them is taking a risk upon ones life. In fact, the whole design of the plant frequently looks as if the designer had finished the plans for the building, and forgot all about the steam plant until some one called his attention to it, then he crowds everything to one side in order to make a little room for it, or else digs another cellar.

Thus are the engineers and men placed in charge of such a plant in daily danger and they are also expected to achieve the same results as if everything was placed under the most advantageous conditions.

Then too the firemen and engine room attendants are not salamanders, they must have air to breathe the same as any other human being. When architects realize this and consult men capable of understanding such matters when they are designing a building they will confer a great boon upon the boiler and engine room employee and also the owner as well.

An instance of the above kind of misplacing of machinery has but lately come to us; it became necessary to remove a boiler that had been placed in a building when it was constructed; upon examination it was found necessary to cut the boiler into several parts before it was possible to attempt its removal. This represented the greatest stupidity upon the part of the designer for surely no one with ordinary common sense would expect a boiler to outlast a building.

Again we repeat it, architects will do well to place more reliance on the engineers advice in matters appertaining to the power plant in our large (or small) buildings, for the engineer and the engineer only is capable of realizing the multiplicity of requirements for that department.

Combustion

By HERMAN T. C. KRAUS, C. E. (civil engineer).

Combustion is the change in the condition of matter from a solid or liquid into a gaseous state. This change in the condition of matter is constantly going on in nature and in various ways, but the occurence of the Oxygen of the air combining with the carbon of fuel, as fire, is in daily life understood to be combustion in particular.

The present method of firing is, with but a little variation, the same as done a thousand years ago; combustion as fire cannot radically be changed because it is the natural course in the change of condition from the solid or liquid into the gaseous state.

The fuel as represented to us by nature free of charge, is in a condition upon which we cannot easily improve by artificial means. Coal for instance, is with the heat units in the most concentrated state–14,000 to one pound, or within about 32 cubic inches. Hydrogen with 62,000 units of heat to a pound is represented by 200 cubic feet.

In order to clearly comprehend the occurrence combustion, or the change in the condition of fuel, we must understand the nature of heat and that heat is a chemical action. Most of the time the explanation of these terms is not comprehensive, being wrapped in mysteries.

Assuming that at some time all matter had been in a gaseous state it is possible as a consequence that the hardest rocks can disintegrate to their former state. The hardest matter may be dissolved by some liquid, but to get this into a gaseous state requires the same amount of heat as it possessed before it represented the respective substance in a solid state.

Heat is a mode of motion, it is not material but functional, to matter it expresses the activity of matter. Heat motion or energy cannot do without matter through which only, or by the support of which, it can act. It will go through solid matter causing the particles of matter to vibrate by which it is advanced. The vibration may be to the extent to expand matter into a fine divided condition or gaseous state. Similar to this is electricity which also is a mode of motion but in a different form.

Many different names are given to heat according to its action supported by water in various combinations, but after all there is only one heat motion, and it will make no difference in what condition matter may appear with it. The different names are only according to the respective condition of matter under the influence of heat energy.

A solid body disintegrating wants heat to resume the gaseous state and which state can only be attained by the particles of the respective substance to be in motion. Matter can be kept in a gaseous state by a certain amount of heat, for instance Oxygen, Hydrogen, Nitrogen, and air, possess a certain amount of heat, specific heat, by which they are kept in their natural condition, this is possible by the present condition of our planet. These four gases are named permanent gases.

This specific heat causing a constant pressure and volume of the gases, can be taken out of it by mechanical work, that is, the heat can actually be squeezed out of the gas and in order to release the pressure, cold water, air, etc, is circulated around the vessel containing the gas. As evident the same amount of heat pressed out of the gas is again required, by the liquid or solid state to which it was reduced, in order to resume the former condition.

A condition cannot change by itself unless something else from outside causes this change by actual work, natural or artificial, and the sum of their work value must be equal to the result of this change.

Matter changes condition in two directions by expanding and contracting of which the former is the most useful for practical purposes. This corresponds with the natural decaying and growing of matter in vegetable as well as animal life.

The natural course of such a change in an icicle can be explained by the water evaporated by the influence of sun heat, it will in a gaseous state rise to the upper regions of the atmosphere, where it is again by cold condensed to water which will fall in drops upon the surface of the earth as rain, forming rivers and ponds of water which by the influence of cold, depending upon the season of the year, this water is reduced to its solid state ice. The term cold only indicates the absence of heat to a certain extent, even in the coldest state we know of sem heat what still remains.

Chemical Action. There is one certain law, although not found in books but is universally prevailing and which reads in short–No difference, no motion, or action. Elements with the greatest difference amongst each other combine most readily to some other substance and this is especially the case with two volumes of Hydrogen and one of Oxygen to water–also will Oxygen and carbon combine forming carbonic acid by one part of carbon and two parts of Oxygen.

A change in the condition of matter can only take place by the particles of the substance in motion causing from one to another a change in their position, consequently a chemical action is nothing but a mechanical mixture of the particles of different substances, causing a difference in appearance than what they formerly had and which is according to their relative position and the relative number engaged.

In chemical analysis it is shown that the particles of two or more elements engaged in the change of a condition, nothing of matter is lost, or disappears, but that the sum of the weights remains the same with every condition may this be solid, liquid, or gaseous state. A pound of water committed into steam remains with this different condition the same weight with every pressure, but heat energy which presses the water in the condition of steam is evident without weight.

The name chemistry is from the ancient Egyptian name chame–chamie or chemie by which was meant Egyptian art. In the language of the people of Memphis, chemie meant also black, for this reason chemistry has been at times named the black, dark or mysterious art.

The combustion in the furnace of a steam boiler as said, is nothing but a change in the condition of the respective fuel from a solid into a gaseous state and as evident, this is accomplished by the particles of, for instance, coal in motion. This violent motion of the particles of matter changing condition is named heat, and this heat motion or energy is imparted to every thing in reach and with the effect to bring it to the same emotion. This excitement for liberty is consequently imparted through the boiler plate into the water, which material is also engaged to equal vibration and as long as this is constantly going on, the particles of the water are separated or expanded to a high degree and to a condition which we name *steam.*

The occurence of fuel changing condition we name *combustion* and the appearance of this we call *fire.* The motion of matter by which this change of condition is accomplished is *Heat;* some of the matter in motion carried by the air to

some distance is the *flame* and is the visible expression of the heat motion *light*.

Oxygen attacks the carbon of the fuel in the furnace and combines with this to carbonic acid, which escapes under the boiler and flues to the chimney, rising within this to a height in the air where it finds equal density. The natural draught of a furnace and chimney depends therefore upon the difference of temperature or density of the gases. The more rapid the combustion in the furnace is going on and the volume of gases increase, stronger will be the force in the direction towards the chimney.

Coal cannot start a fire by itself, but like everything else this must be accomplished by something outside and which is in this state of fire already.

The particles which actually constitute the unit of coal, represent by accumulation the mass of coal. The intensity of heat depends upon the state of perfection within these particles and not upon the mass of coal, for these particles *only* are attacked by the Oxygen and again their degree of density depends upon how perfect the combination of the particles with the Oxygen can be accomplished, forming carbonic acid. The mass of coal gives a quantity of heat which is the concentration of heat in the mass and the amount of steam made depends upon the quantity of heat in the furnace and how well this is distributed over the heating surface.

Coal combines a certain amount of foreign matter not a combustible, which varies according to the solid upon which the wood was growing at an unknown time. To all this the shiftings of the coal beds in its early days have admitted some other matter etc. Coal as is well known is wood which in time was transformed into the present state; anthracite is considered the hardest and oldest coal.

The combustion in a furnace is not artificial but under artificial treatment. The amount of useful work out of all the heat developed in the furnace, without having reference to the intermediate parts, is actually with the tool producing articles of manufacture. A ton of coal contains about 25 millions of heat units and with these transformed into motion by combustion we ought to be able to accomplish a great deal of useful work, but this is not the case. We may ask what becomes of all the expenditure of value as heat and will find that much, very much, must be paid out on the way to the actual result and that this is but a trifle of what is expended for the purpose.

The utopia of a manufacturer would be to run the coal by automatic machinery from the mine into the furnace and have within the factory rude automatic machinery by which a day's work can be obtained without any personal attention.

Oxygen, the one-fifth volume of air, is equally mixed with the Nitrogen in the remaining four-fifths volume of air. Through the grate the Nitrogen has free passage through the furnace in order to give the carbon a chance to absorb the accompanying Oxygen. As evident this cannot completely be accomplished, depending as it does to a great measure upon the state of the fire and other circumstances. Should the fire be down showing black spots and at that time be supplied with a charge of coal I think, the result will be a poor distilation of the coal, by the little heat below, the volatile or oily matter will free itself and escape through the chimney without doing the least of good, it absorbing and carrying away the heat in the furnace. With fire rising within the coal the distilation is improved, but only to form carbonic oxide, which is carbon half with Oxygen, because there is not heat enough to complete the combination, nor time to accomplish this, for the fresh air is constantly pushing forward.

This carbonic oxide also escapes with but little benefit. After the fire breaks through the mass of coal the formation of carbonic acid is accomplished and while this is going on the greatest heat is developed as it is the most favorable condition in the furnace. This explains that a certain condition can be the support for the development of another and in the furnace with the necessary temperature the carbonic oxide can develop the carbonic acid, that is, with the additional amount of Oxygen.

Assuming a grate of 4 x 6=24 feet square and that each square foot will burn 30 pounds of coal or 24 x 30=720 pounds of coal per hour, now allow 150 cubic feet of air containing Oxygen enough to be theoretically necessary for combustion, which is 720 x 150=108000 cubic feet of air in one hour, or the constant supply of 30 cubic feet of air with a velocity of about 4 feet a second. Assuming that only half of the Oxygen in the air is absorbed by the carbon in the coal and that the amount of air is to be doubled, then the air will go with a velocity of 8 feet a second through the grate and fuel. The air going through the fuel with moderate velocity is undoubtedly of advantage, the Oxygen is instantly absorbed by the carbon, although it takes a certain time, no matter how little, within which the carbonic acid can be formed, but which by the air shooting through the fire to rapidly is neglected. Certainly by natural draught the velocity of the air depends upon the nature of the fuel and the height of the grate. By the application of artificial draught with a motion fan, the supply of air can be had with a constant pressure and can be regulated according to circumstances. We all know that without the closest attention no correct result can be obtained and this should be conducted as punctual as within a labratory.

Should the air be deprived of the Nitrogen by some simple process and only Oxygen admitted to the furnace, this furnace would have to be hemetically closed in order to keep the air out of it. The heat could in this case be much increased because it should not be divided amongst the other four-fifth parts of air occupied by the Nitrogen. The Nitrogen is undoubtedly a carrier of heat but otherwise of no special advantage in the furnace developing heat. The grate bars with only Oxygen going through them would soon be destroyed, but by the intense heat the facilities would be increased to impart heat through the iron into the water. As well as this may appear, on account of many difficulties Oxygen only cannot easily be applied for practical purposes.

Should the grate constantly be supplied with a very light layer of coal the furnace would then be the coldest place and could as well be outside within a special setting. The gases distilled out of the coal instead of shooting through and on the heating surface to the chimney, can at different compartments or stations be retained for the special development of heat, that is if what is left in one compartment incomplete can be developed in the next one. The trouble with such an arrangement should be the lack of heat in the compartment not directly connected with the furnace.

Perfect combustion can be the nearest accomplished at the spot where the carbon and Oxygen come in close contact, which is within the fire, after the combustibles leave the furnace they are spread in large volumes of gases which can be obtained as stated above, but it is thus similar to the saying–it is easier to prevent a sickness than to care for it, therefore the combustion within the fire is as perfect as possible.

READING.

The Convention City as It Is.

Not in the history of the American Order of Steam Engineers will delegates and visitors to the Annual Convention have had opportunity to acquire such varied and interesting experiences, as will those persons attending this pleasurable event in the Organization's business routine at the city of Reading on May the 12th next.

To those who have never visited that city the experience will undoubtedly be replete with pleasant surprises, not only in the constantly changing scenery going to and from there, but also in the manner of the people. In order that the visiting delegates may not miss some of the most interesting features of this historical place, and also that those members of the American Order and other readers of THE PRACTICAL ENGINEER who may not be able to be present will be in a position to enjoy some of its interest, we will endeavor to portray Reading as it really is.

VIEW OF READING, PA. FROM FOOT OF PENN ST., SHOWING MOUNTAINS IN BACKGROUND

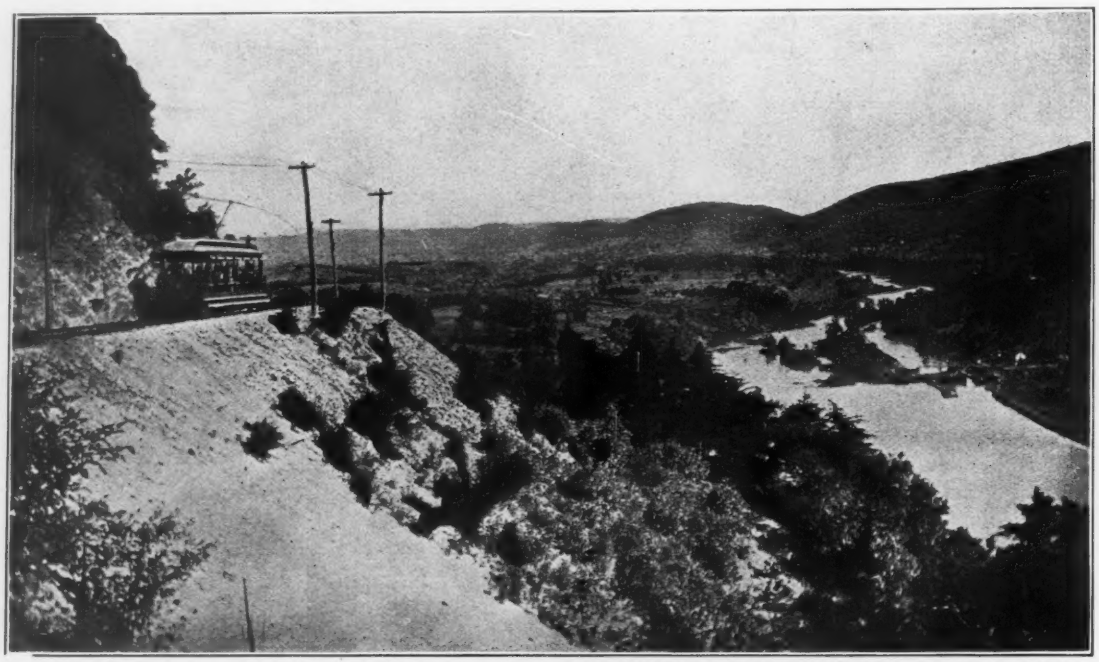
Under the shadows of Mount Penn, Mount Washington and Neversink Mountain, in a bowl-like contingent of the beautiful Schuylkill Valley, the city was laid out nearly two centuries ago by William and Richard Penn, and it was named by them Reading, after the English Cathedral town of that name, and is, next to Philadelphia, the oldest town in the State of Pennsylvania. In the matter of manufacturing it is second to no inland city in America of its size; the cotton factory, the woolen mills, the flour mills, breweries, foundries; the great construction and repair shops of the Reading Railroad and the huge blast furnaces of the different steel and iron companies, go hand in hand with the almost unparalleled natural beauty of the city's surroundings in making it a great panorama of interest to the visitor.

There is no more beautiful scene to be had than that approaching Reading from the East at night on the Reading Railroad. As one approaches, the first object to be noticed will be that of the grand old Neversink Mountain, high up upon which can be seen the ever twinkling lights of the magnificent Neversink Mountain Hotel. A close approach will distinguish the tortuous outlines of the trolley line with its ever ascending circles; but even as the train reaches the base of the great mountain itself there is no suspicion of the fairyland beyond, right here a glance to the South will show the placid waters of the Schuylkill seemingly almost directly below the cars yet fully a hundred feet of sheer descent below. Then we round the last curve of the mountain to have suddenly burst upon our view a scene which once seen can never be forgotten; for a moment the whole valley seems to be alive with dazzling and kaleidoscopic views, each rivaling the other in point of beauty, on the right may be seen a huge bank of slag, hundreds of feet in heighth, with its banks semi-luminous, while here and there are to be seen perfect rivulets of molten lava flowing from newly dumped slag cars, each emitting millions of tiny glittering sparks of fire, the whole going to make up a scene which will alone repay the trouble of the trip. A glance beyond this will show upon all sides the rising hills of the Eastern extremity of the Blue Ridge Mountains.

This is a night scene which while beautiful will have a strong second in the thoughts of the visitor by the cordial

manner in which he will be treated by the people of the city itself. Here again is a surprise, instead of a quaint old-fashioned town, as one might expect to find here in the mountains, you are introduced into a veritable metropolis, the huge factories, the high office buildings, the rush of the automobile and all of those things which are necessary to the highest Twentieth Century success are to be found.

After the first effect of surprise has worn off the visitor will become more and more impressed with the thoroughness of the place. In no other way can this be properly appreciated than by a trip late in the afternoon over the mountains on the famous switchback electric railway, returning by night. A ride of four miles is accomplished in about twenty minutes and the traveler arrives at the summit of the Neversink Mountain. Here reared upon its loftiest peak is an edifice which shows well the thrift that has made Reading so successful; a Hotel



THE SCHUYLKILL VALLEY FROM NEVERSINK MOUNTAIN RAILROAD

365 feet in length, five stories in height, with a promenade porch open to the public of 900 feet in length. From this point of vantage the view is unsurpassed; to the East and South the eye can travel for miles over the slightly undulating country, winding through which can be discovered like a silvery cord the waters of the Schuylkill River. To the North and West can be seen the rugged outlines of the mountains which in their grimness suggest well the enormous stores of mineral wealth which lay beyond.

As night approaches and the huge smelting furnaces belch forth their volumes of flame and smoke in fitful glares, momentary glimpses can be had of the workers far below as they rush to and fro.

In the city streets the visitor will find everything cosmopolitan in the highest degree, except for the kindly courtesy with which he will be treated by all. The business houses rank with the best in the country in point of variety and quality of their merchandise; the city improvements in the nature of electric lights, water works and asphalt streets rank with the best of our larger cities.

To the visitor is always extended the hand of good fellowship, and if those who attend the Convention this year do not have a good time in every way, it will be through no lack of hospitality upon the part of Reading's citizens, nor yet upon no lack of interesting and versatile subjects for the mind to study and the eye to comprehend, for in this old town will be found all that is new and enterprising as well as all of that old-fashioned good cheer which go to place at ease the stranger within its gates.

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Air and Its Uses at and Below Atmospheric Pressure.

By a vacuum is meant the beginning of atmospheric pressure. It is from this absolute point or pressure from which nearly all air calculations start. And like the absolute zero of temperature, it is the point at which the expansion of air becomes infinite.

The most simple means by which the pressure of air is reduced from atmospheric pressure is by the use of the air pump. While with a well constructed air pump we can produce a very good vacuum, yet with this class of apparatus it is impossible to produce a perfect vacuum. Its degree of perfection being limited by the volume of its clearance divided by the volume of its piston stroke and by the perfection of its construction. It is very rare to get a vacuum better than one-hundredth of an inch of mercury with the pump, while it is more common to get a limit of one-tenth of an inch.

A very common form of air pump is that known as the Venture vacuum pump, being named after Venture, its discoverer. Its principle being that a fluid passing at a high velocity through converging and diverging nozzles, and from an orifice, will produce a vacuum at the point nearest to its greatest contraction. If a pipe leading to a vessel, from which we wish to exhaust the air, is connected at this point we will be able to exhaust nearly all the air from this vessel.

But when we need a more perfect vacuum than can be secured by any of the preceding methods, it becomes necessary to resort to the Sprengel or Mercurial air pump. The most common type of air pump known to the engineer is that of the combined condenser and air pump, used in many condensing steam plants, its construction being too well known to need explanation here. With this type of pump in good working order, we should secure a vacuum to within 1′ of Mercury of absolute.

The vacuum has many uses outside of the economy of its use in connection with the steam engine. All of the incandescent electric lamps which we use owe their life to the fact that their interior is almost a perfect vacuum. If this were not so, the oxygen of the air would consume the filament at a very early period.

The vacuum has a great commercial utility. Eggs are broken into large pans which are placed in vacuum chambers and their moisture is expelled by a very low temperature, thus producing a dry powder which contains all the valuable food constituents of the egg and which may be kept for almost an indefinite length of time. In a similar manner nearly all kinds of fruits and vegetables are now evaporated. Large numbers of the big products of different manufacturers are saved and made valuable by being dried in a vacuum.

In drying of different products of food in the atmosphere such a high temperature is required to drive off the moisture that many of their valuable food constituents are also driven off, while by drying them in a vacuum all this danger is overcome. By the use of the vacuum process a dry food stuff is secured which is very satisfactory in appearance and rich in food properties.

One of the most useful as well as interesting vacuum processes is that used in the manufacture of salt. This is known as the triple or quadruple effect system, the name depending upon the number of stages of evaporation. Fig. 1 shows the arrangement of a triple effect vacuum apparatus. The boiling chamber A of the first section being in communication with heating chamber B^1 of the second section by the pipe R, the second boiling chamber A^1 communicates with the third heating chamber B^2 by the pipe R^1 while this latter boiling chamber is in connection with the condensing chamber P of the vacuum pump.

The heating chamber B of the first section is connected through the pipe C with a boiler or to the exhaust of an engine. All of the boiling chambers communicate with the vacuum chamber of the pump by a very small pipe not shown. The purpose of this pipe being to maintain a vacuum in these chambers yet not of sufficient size to carry away any considerable quantity of the steam produced or generated in each boiling chamber. It will thus be seen that the steam produced in one boiling chamber is used as the heating medium in its succeeding evaporator, thus conducing to great economy. Pipes o, o, o, lead from the heating chambers to the trap T

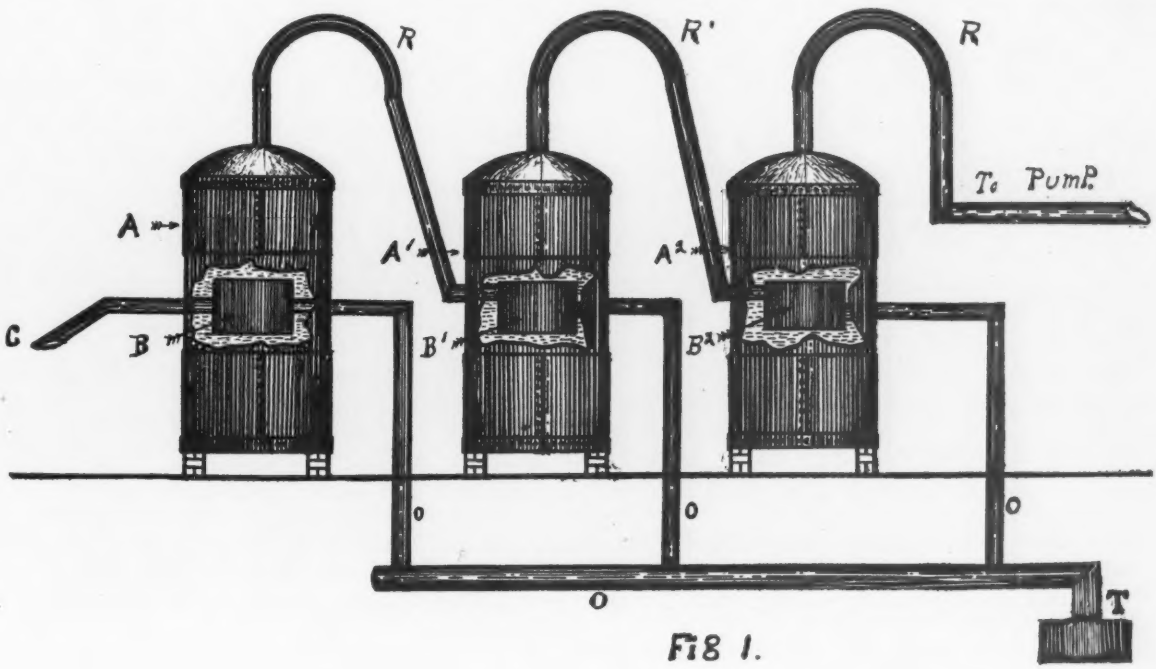

Fig 1.

which takes away the water of condensation. The steam as it condenses in each boiling chamber produces a vacuum in its preceding boiling chamber. It will readily be seen that the highest temperature and lowest vacuum exists in the first section and visa versa in the last section.

This process could be continued, using more chambers if it was so desired. This process of multiple effect is used in many processes where it is necessary to reduce liquids by boiling or to precipitate their solvents. All of the evaporating ships used to supply fresh water to vessels of war are fitted up with apparatus of this type. In Philadelphia, where the water is more like soup than water, this process is used for producing distilled water for drinking and cooking purposes. With well constructed apparatus it is not uncommon to produce 1,100 gallons of distilled water at a cost of fifty cents.

The simple syphon used for drawing liquids from one level to another over an obstruction is an illustration of the use of air at atmospheric pressure. Its application has been known for hundreds of years; it is said that its use was known even before the Christian Era.

MAX.

Old Friends in New Clothes.

PART VI.

BY A. EDWARD RHODES.

It is said that the advance of civilization, as well as that of science, may be measured by the progress which is made towards the utilization of waste. Things that are now sources of profit were, at one time, regarded as useless. Great efforts are continually being made to find new uses for that which is now useful and a use for that which is now considered wasteful. Possibly the most striking utilization of what had previously been considered as waste, was the discovery of a means by which cotton seed could be used. Formerly the cotton planter had to plan how to get rid of his cotton seed. Sometimes it was carted away at more or less expense and thrown into the rivers where it either was carried out to sea or helped to fill the channel, sometimes to such an extent that an appropriation from congress was required to dredge and deepen the river for the passage of boats. After many experiments were tried the full realization and possibilities of cotton seed was discovered. The seed was crushed for its oil, and the seed—oil cake, as it was called, after the oil had been extracted, was found to be a fine food for cattle, and later, as a basis for soap. Next it was discovered that it made a good fertilizer, and now the hulls are made into paper. So that what once cost the planters of the south many hundreds of dollars to get rid of now brings in almost if not quite $25,000,000 a year.

But this is not so wonderful as the triumph of science which takes place in the black coal tar of gas retorts, which for many years was regarded as useless. But now we get from it the aniline dyes of so many shades and hues. The first chemical compound made from coal tar was, pyridine, the basic group of many alkaloids. From it was obtained antipyrine, atropine, phenacetine, hynal, and many others. Saccharine, two hundred and eighty times sweeter than sugar, is another element found in coal tar.

Sawdust is now mixed with special refuse mineral products, and under heavy pressure, is made into bricks, which are light, impervious to wet, and are fire-proof. Three qualities which make a brick of superior qualities. A chemist has made a finely divided and very valuable charcoal from sawdust, and I saw in a paper sometime ago that sawdust is now being used in mixing mortar instead of hair.

Sludge acid has been one of the most offensive wastes known to man. Its existence has been the bane of man. For many years it has deadened the nerves of smell of the citizens of Long Island City and Staten Island. It is made by agitating a certain quantity of sulphuric acid with a thousand gallons of distilled petroleum, intended for illuminating. A beautiful, pure white acid went into the agitator, and what came out was a molasses-colored acid, whose color but feebly suggests the vileness of its odor.

It was run into the harbor until even the harbor could not stand it and rebelled. Then the oil company built a tank steamer for the sole purpose of taking this sludge acid out at night and burying it in the sea. This cost the refineries a vast sum of money. Sludge acid when it is young is frothy; twenty-four hours companionship with itself makes it black and waxy. One day a chemist (we will never be able to estimate the good done by the chemists) took some fresh sludge and threw it into fresh water. He noticed that upon being thrown into the water it separated into oil and acid. The acid was easily absorbed by the water, and the residue of oil, it was found could be used as fuel. Now the companies separate the sludge into oil and acid, and cannot supply the demand for the oil for fuel.

Slag, which used to be the despair of all owners of puddling? furnaces, and is banked high in their neighborhood (may be seen at Reading during our convention) as a monument to its own usefulness, is one of the latest converts to the ranks of the useful. It is now used in the manufacture of paint, being valued for the fifty-five to seventy per cent. of pure oxide it contains. Slag, when pulverized, is absolutely fire-proof and experiments looking to the using of slag in the place of asbestos are now being made. It is also used to clean silver and brass, and can be made into soap.

I have given a few of the great savings made, now least I give the impression that we have reached the top notch of perfection, although much has been done by science towards the utilization of waste, there are many directions in which there still is much to be done. It has been ascertained that in the average manufacturing establishment from fifty to ninety per cent. of the power employed (made if I may so use the word) is wasted by friction. In oil or gas light it is stated that more than ninety-nine per cent of the energy is expended in heat, a great loss of light and a mighty discomfort in summer.

[TO BE CONTINUED.]

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Description of Absorption Plant.

There are two classes of ammonia used in absorption machines, anhydrous and aqua ammonia.

Anhydrous ammonia, as its name implies, is free from water. At ordinary temperature it is a gas, but it liquifies if subjected to a low temperature, say 35° below zero, or a heavy pressure, or a combination of both.

Aqua ammonia is a solution of the gas and water.

In the distribution of ammonia when the absorption machine is in operation under normal conditions, aqua and anhydrous ammonia are distributed as follows: Aqua ammonia is contained in the generator (G) analyzer (A) exchanger (E) absorber (B) and pump (P). Anhydrous ammonia is contained in the condenser (C), the rectifier (R) contains ammonia gas, also a small quantity of aqua ammonia which is to be separated from it.

The generator as its name implies, is for the purpose of generating the anhydrous ammonia gas from the aqua ammonia. It consists of a cast-iron cylinder, having a T at one end, on which is placed the analyzer. The generator is built on the same principle as a return tubular boiler. The heating surface consists of a steam coil in place of fire tubes.

The aqua ammonia is contained in the shell, the coil being entirely submerged in the ammonia. When heat is applied to the coils by the means of steam, ammonia gas is driven off from the solution and passes up through the trays of the analyzer.

The duty of the analyzer is to heat the down-coming strong aqua ammonia, which drops from tray to tray, by means of the ascending hot ammonia gas which in turn becomes cooler.

The purpose of the exchanger is to exchange heat between the cold strong liquor and the hot weak liquor, rendering the weak liquor cold before it enters the absorber, and the strong

liquor hot before it enters the analyzer. This is effected by means of helical coils heated inside the shell.

The pump discharges the strong liquor into the bottom of the shell and out of the top into the analyzer. The incoming hot liquor enters the top of the coils and passes out of the bottom to the absorber.

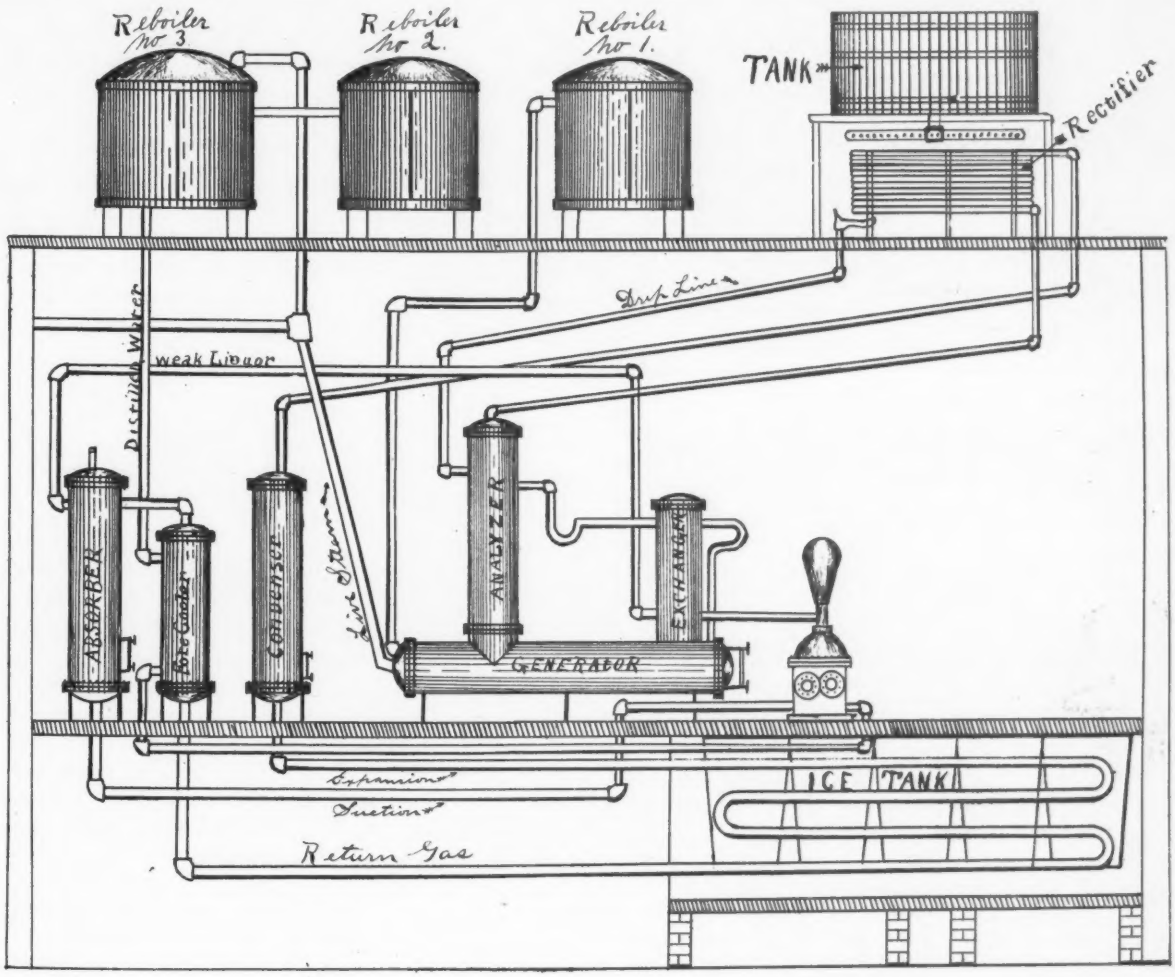
The rectifier is for the purpose of abstracting any moisture that might be contained in the gas leaving the analyzer, the object being to condense any moisture in this gas in the pipes of the rectifier, by means of a stream of cool water traveling over the coils. The condensed vapor returns to the analyzer by means of the drip line, which gives us very nearly pure anhydrous ammonia to the condenser.

absorb the ammonia gas it is divided into numerous small streams which meet the return gas from the freezing coils.

The forecooler is for the purpose of cooling the distilled water for filling cans by the action of the return gas from the freezing coils.

The reboilers are for the purpose of distilling water by the use of the return steam after it has done its work in the generator.

There are some features in the absorption system that are far superior to the compression system. Much purer ice can be made for the reason that there is no oil used in connection with the system that comes in contact with the steam. Another feature is that you can carry your brine at a much lower



The condenser is for the purpose of condensing the anhydrous ammonia gas after it leaves the rectifier. Ammonia gas will condense at a low pressure if subjected to a very low temperature, or a combination of both. These conditions are achieved in the condenser by the cold water which passes through the condenser coils, giving a comparatively low temperature, and by the pressure produced by the generator.

The absorber is for the purpose of sucking the return gas from the freezing coils into the absorber, by the absorption action of the aqua ammonia from which the gas was originally generated.

The weak liquor line takes its weak liquor from the bottom of the generator and carries it to the absorber, to properly

temperature than with a compression system. So in the use of cold storage work you do not need to run the machine continually, but by the use of a brine cooler you can run your brine to a very low temperature, say 28° below zero, and shut your machine down for a period of from eight to ten hours, and circulate your brine through your house for that time.

As far as economy is concerned in the absorption system, I will say that it can be run as cheap as the compression system, when the results are taken into consideration. By the use of exhaust steam it can be run cheaper than the compression system, but the objections are in separating the oil from the exhaust steam for making distilled water.

Philadelphia, Pa. L. J. PIERCE.

The Practical Engineer.

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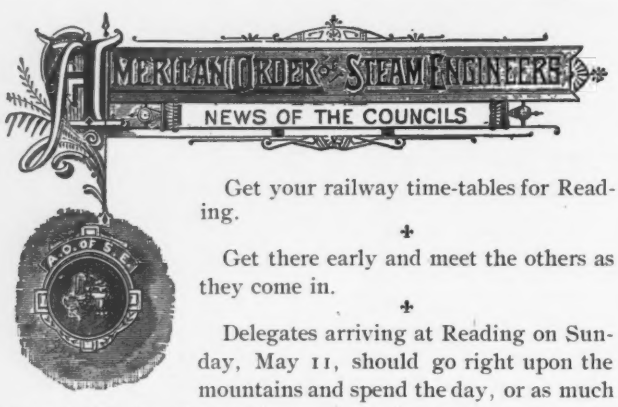

Get your railway time-tables for Reading.

✣

Get there early and meet the others as they come in.

✣

Delegates arriving at Reading on Sunday, May 11, should go right upon the mountains and spend the day, or as much of it as is left after they arrive. If the time is short go up on Neversink first. Take electric cars at Ninth and Penn streets.

✣

Reading, Pa., can be reached from New York and the East by way of Easton and Allentown, from Washington and the South by way of Philadelphia, via either the Pennsylvania or Reading Railroad or if Southern delegates wish to do so they can change cars at Wilmington, Del., and go up to Reading on the Wilmington and Columbia Railroad. From the West by way of Harrisburg and Lebanon. From the North by way of either Harrisburg or Scranton.

✣

Three new Councils of the A. O. S. E., have been formed during the past month. One in Texas and two in Pennsylvania. Iron City Council, of Pittsburg, with 85 charter members, gives every promise of becoming one of the best engineers' organizations in the country. Germantown Council, of Philadelphia, with 60 charter members, states with brighter prospects than any of the now large Councils in this city did. Both of these latter Councils were organized by Mr. L. L. Rice, of this journal since April first.

Large New Council of the American Order of Steam Engineers.

On Saturday evening, April 19, Grand Chief Hiram M. Trout, assisted by Grand Junior Master Mechanic Thomas Marshall, Jr., instituted a new Council of the A. O. S. E., at Pittsburg, Pa., with 85 charter members. The Council will be known as Iron City Council, No. 21, and will hold regular meetings every Saturday evening, at 1040 Fifth Avenue.

The officers are as follows: Chief Engineer, M. J. O'Sullivan; First Assistant, Walter Shook; Recording Engineer, John McF. Easton; Financial Engineer, Joseph Kocab; Corresponding Engineer, F. C. Rose; Treasurer Engineer, W. J. Vandergrift; Chaplain, C. W. Taylor; Senior Master Mechanic, John B. Morton; Junior Master Mechanic, John Kleber, Inside Sentinel, J. O. Cowger; Outside Sentinel, Watt Liermann; Senior Past Chief Engineer, John McF. Easton; Junior Past Chief, L. F. Vandegrift.

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A New Council in Texas.

A new Council of the American Order of Steam Engineers has just been organized at Galveston, Tex., and will be known as Galveston Council, No. 1. This Council starts with a charter membership of twenty. We have not yet received the names of officers, etc., but will give them in our next issue. This Council was formerly a branch of the N. A. S. E.

✣

Another Council in Philadelphia.

A new Council of the American Order of Steam Engineers was instituted in Germantown, Philadelphia, on April 30, with 69 charter members. This makes eight Councils in this city, all prosperous, and more to follow.

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From Oregon No. 1, American Order Steam Engineers.

Grant's Pass, Oregon, March 15, 1902.

Be it resolved that:

Whereas, it has pleased the Supreme Engineer of the Universe in his infinite wisdom to remove from the sphere of her earthly usefulness the beloved wife of our Brother O. C. Baker;

And while we bow in humble submission to the Divine will;

It is hereby resolved that we express our heartfelt sympathy with our Brother in his bereavement.

And be it further resolved, that a copy of these resolutions be placed on the minutes of the Council, and also that a copy be printed in the county newspapers.

Committee on resolutions:

Benj. F. Myrick.
S. A. Williams.
T. N. Feese.

✣

Grand Council Resolutions of Condolence.

Allentown, Pa., March 18, 1902.

At the Annual Convention of the Grand Council of the State of Penna. A. O. S. E. held on the above date the following resolutions were unanimously adopted:

Whereas, it has pleased the Almighty God to remove from our midst our friend and Brother Harry B. Underwood:

And whereas Brother Underwood has always shown marked love and devotion to our noble order, and has given much

time and energy to its interests, contributing largely to its success: therefore be it

Resolved, that this Grand Council bow in submission to the will of Him who doeth all things well. And be it further

Resolved, that we extend our sincere sympathy to the bereaved wife and family, and express the belief that their loss will be his eternal gain.

Resolved, that a copy of these resolutions be sent to the family and entered on the minutes and be published in the official journal of the A. O. S. E.

HIRAM TROUT,
WM. J. COURTNEY,
FRANKLIN R. MOORE,
Committee.

\+ + +

The Coming Convention of the American Order of Steam Engineers.

At Reading, Pa., where the next Annual Convention of the A. O. S. E. will be held on May 12 to 15, the Committee in charge of arrangements have their preparations well under way and promise all delegates and visitors a pleasant time. The programme has not yet been completed, but it has been

decided that a reception for engineers, exhibitors and supply men will be held in the Convention hall on Monday evening. Tuesday afternoon will be spent on the mountains, and Tuesday evening a grand banquet will be tendered in Rah Jah Temple.

The headquarters for the Convention will be at the American House, and the genial proprietor, Geo. M. Ammon, promises first class accommodations to all. Rates will be $2.00 per day.

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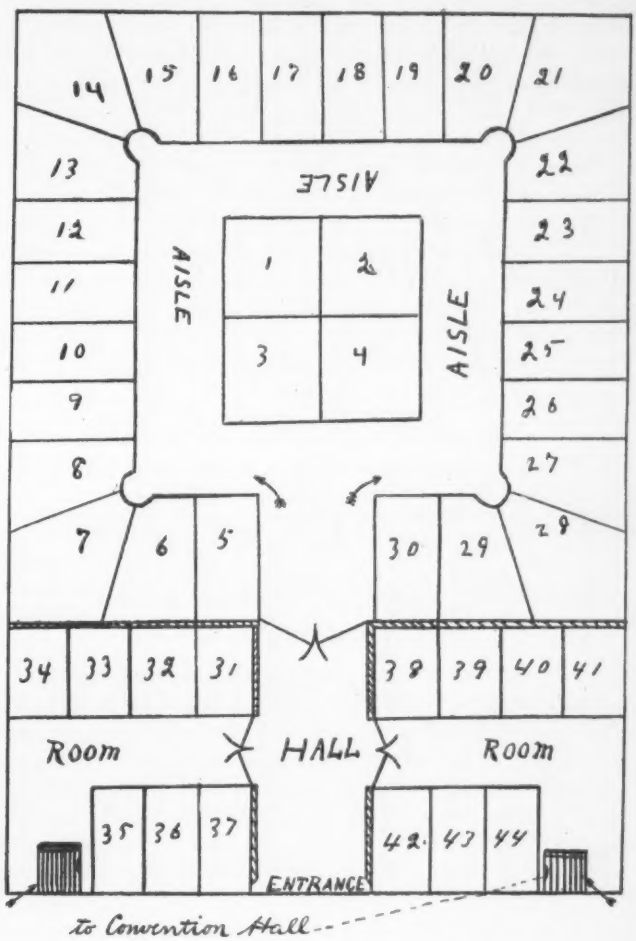
Manufacturers and Agents Welcome.

The Committee extends a cordial invitation to all manufacturers of or dealers in steam engines, boilers and appliances to be present at the Convention of the A. O. S. E., at Reading Pa., May 12, 13, and 14, for the purpose of exhibiting their products, distributing catalogues and advertising matter, or merely for the purpose of enlarging their acquaintance among engineers. Any person who cannot attend personally or send representatives may forward a supply of catalogues or other advertising matter and the Committee will see to it that it is judiciously distributed.

Good Advertising.

The Convention Committee at Reading state that they still have some space to let for exhibition purposes. Those desiring to exhibit steam specialties or supplies should apply at



once. The cost of the spaces that are left are but $5 and $10, each. For further particulars address A. Keppleman Secretary, Board of Trade Rooms, Reading, Pa.

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Fun at Camden.

The members of Camden Council, No. 3, of New Jersey, celebrated their sixth anniversary at their rooms, at Second and Federal streets, on Thursday evening, April 24th, with an open meeting, and as is customary with everything that Camden attempts, the affair was a complete success, and a genuine treat to all having the good fortune to be present.

Some two hundred visitors filled the hall a little beyond its normal capacity, and the night was pretty warm, but these were things beyond the power of the committee in charge to change, otherwise they too would have been perfect.

It was an unconventional affair, being primarily intended to bring together old and new members of the Order, therefore no set programme was followed. Supreme Corresponding Engineer J. C. McDowell opened the meeting with one of his characteristic speeches, which never fail to put everyone in a good humor. A pleasant surprise was then sprung upon the members of Camden Council, Brother James McNelly pre-

senting the Council with a very handsome large new book case, made of quartered oak, with plate glass doors. Supreme Chief Engineer C. P. Williams delivered the presentation speech. Following this brother surprised the boys still further by presenting the Council with a full set of Hawkins' Works, six volumes, the presentation address being by L. L. Rice. Short talks of general interest to engineers and the Order were given by Deputy Supreme Chief F. O. Garrison, Thos. Marshall, Jr., F. R. Moore, Frank Mellor, Joseph Wheaton, and others. Ex-Mayor Hatch also delivered a very interesting address, dividing his attention between the necessity for an engineers' license law in New Jersey, and the Beef Trust. He was roundly applauded.

An excellent musical programme, furnished by the Camden National Band kept things lively throughout the evening. Chief Engineer S. R. Middleton, presided, and the following gentlemen composed an exceptionally good Committee of Arrangements: Horace Hewlings, Mark Rowland, Julius Abrahams, H. R. Taliaferro, Chas. Harrigle, Samuel M. Best.

* * *

Educational Committee, A. O. S. E.

JOHN MARTIN, Secretary, 2655 East Clearfield St., Phila.

The following questions are intended to create discussion in councils of the American Order of Steam Engineers. Answers will not be required by the Committee but prizes will be awarded by the Committee for the best essays prepared by individual members upon any of the questions asked. The PRACTICAL ENGINEER will give cash prizes for the best essays prepared by engineers whether members of the A. O. S. E. or not.

Questions for May Issue.

1 What would be the trouble with a compound Wound Generator if the voltage would drop considerably when full load was on the Machine and the speed of the Engine would stay steady, they being direct-connected?

2 What would be the effect on a 4-circuited armature if one set of Brushes got out of contact with the commutator?

3 What would be the effect on a two-circuited Armature if one set of Brushes got out of contact with the Commutator?

4 How would you jump out a coil in a four-coil, four circuited Armature?

5 How would you jump out a coil in a four-coil, two-circuited Armature?

6 What degree of bevel is required on the safety valve and its seat by the United States Government Boiler Inspection Department?

7 Why would 23 degrees not be sufficient and 55 degrees too much?

8 What would be the difficulty if your safety valve were to have 75 degrees bevel?

9. What is the proportion of area in square inches of safety valve to the square feet of fire grate, and if the boiler pressure were 60 lbs. and 150 lbs., would the safety valve area be the same if grate surface was same?

10 What is the volume of steam at 60 lbs. pressure and how much less at 150 lbs.?

* * *

Controversy between Engineers and Brewery Workers in Cincinnati.

A controversy of more than usual interest to engineers has for some time been going on between the Brewery Workers' Union of Cincinnati and local unions of engineers and firemen employed in the breweries of that city.

The Brewery Workers composed of the men who wash kegs and perform similar duties around the breweries demanded that the engineers' union should dissolve and its members join the Brewery Workers' Union. This the engineers and firemen refused to do for the reason that they are working under a contract with their employers and for the very excellent additional reason that the employing brewers have given them everything they asked, including an eight hour day.

The Brewery Workers then declined to work with the engineers and went out on strike which has lasted for six weeks and has seriously crippled the brewing interests of the city and keeping their own members out of employment.

The fight does not involve a question of hours or wages, but is wholly against the engineers and firemen, who positively refuse to surrender. The employing brewers representing an industry with an estimated capital of $28.000.000 are therefore the innocent victims of a controversy which they have no power to settle either way.

Mr. Henry Ketter, President of the Engineers' Union in an interview says:

"I can summarize the whole situation by saying that the Brewery Workers might as well walk into the offices of the

breweries and ask the clerks and book-keepers to join their unions as to ask us to do so. The idea I mean to convey is simply this: To be an engineer a man must have some training and education and be of more than the average intelligence. He must be able to pass an examination to obtain a license, and this requires study and work. Now, the men who had acquired these licenses were formed into a union of their own and were in thorough accord with union labor. It might as well be said that every carpenter that works in a brewery, or every painter who puts on a bit of paint on its walls must join the Brewery Workers' Union as to say we must. We are all strong union men, but we do not believe that we should dissolve our union.

Mr. Henry Ketter is 36 years old, has grown fat from laughing, and is unquestionably the most popular engineer in the city of Cincinnati. He has followed the profession of stationary engineering from boyhood, and is a mechanic of

undoubted ability. He was the last City Inspector of Engineers of Cincinnati, prior to which he held positions as Chief Engineer of the City Water Works for two years, Government Building two years, Nihalovitch, Fletcher & Co., distillers, five years, United States Printing Co., the Russell Morgan Factories, etc. He was the Democratic candidate for Congress from the 2d District of Ohio, in 1900, and received the largest vote ever polled by a Democrat in that District, being defeated by a small margin. He is often referred to as the silver-tongued engineer.

Mr. Ketter is President of Engineers Union No. 18, of Cincinnati, which has been successful in establishing the 8-hour day in a large number of the continuous-running plants of that city, such as municipal plants, breweries, hospitals, and some of the larger hotels. The Cincinnati Gas and Electric Light Co. will also conform to this rule, commencing July first, all of which excellent work has been accomplished without any strikes on the part of the engineers.

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The Average Pressure on a Steam Piston.

By W. H. Wakeman.

The "average pressure," and the "mean pressure" of steam, both of which refer to the same thing, or have the same meaning, are so frequently used incorrectly in many of our mechanical books and papers, and the practice is continued so persistently by some of them that a short article on the subject seems to be called for, in order to correct the inaccuracy and prevent others from falling into the same error.

Some of these periodicals tell us that when we want to determine the horse-power of an engine proceed as follows.

"Multiply the area of steam piston in square inches, by the travel in feet per minute, and by the average pressure," but we will cut the rule short here, because the average pressure is not used for this purpose. Sometimes an engineer wishes to know if there is a rule whereby he can determine the mean effective pressure on the piston of his engine, without an indicator. He is told to find the ratio of expansion, and one or two other things, when by properly adding, dividing and subtracting, the result will be the mean pressure, when that is not what he wants and usually the answer will not be the mean pressure.

A certain author wrote an article on how to find the mean effective pressure from an indicator diagrame. It was well illustrated and showed how to lay off said diagrams by ordinates, and to measure the distance on each one of them, from the steam and expansion line down to the counter-pressure line, etc. We were told to use the proper scale for this purpose, add all the results together, divide by the number of measurements taken and the quotient would be the average pressure?

When this writer was asked to explain the difference in results between those secured by his method, and those attained by use of a rule given by a standard authority on the subject, he replied that in his case the effect of clearance, compression, wire drawing &c., were taken into consideration, while the rule did not take these into account, but this explanation was neither satisfactory nor correct, for the mean effective pressure shown by an indicator diagram from an engine in good order, agrees very closely with that computed by a correct rule that is given us for the purpose of determining the same pressure, but when the mean effective pressure is determined by use of ordinates, and the mean, or average pressure is computed by a rule, the results must of necessity differ widely, provided that both processes are carefully carried out, for the simple reason that they call for two very different things, which can never be alike in a noncondensing engine, and will only agree in a condensing, when the condensing apparatus creates a perfect vaccum in the exhaust pipe, which is a feat that never will be accomplished, judging by the results of previous efforts along this line. Let it be plainly understood that this is not a discussion of right and wrong ways to apply a certain rule. but it is an explanation of the blunders made by writers who used a good rule for a purpose that it was never intended for, then wonder at the unexpected results secured, or else never suspect that they have made a blunder.

Fig. 1

The mean effective pressure acting on a piston is one thing, the mean pressure, or the average pressure is another, as will be shown presently. The indicator diagram shown in Fig. 1, was taken from a 28-inch Corliss engine, in the vicinity of my place of writing, and is a fair specimen of every day results secured in that plant.

By tracing the lines with a planimeter I find that the mean effective pressure is 30 pounds. Let us now proceed to apply the standard rule given us for determining the mean effective pressure on the piston of an engine, when all required data are given. It will be necessary to find the ratio of expansion, as the first step. The total length of this diagram, including the estimated clearance is 3.75 inches, and from the clearance line to the point of cut-off is .5 inch. The expansion rate is then $3.75 \div .5 = 7.5$. The hyperbolic logarithm of 7.5 is 2.0149, and adding 1 to it gives 3.0149, which is to be divided by the ratio of expansion and $3.0149 \div 7.5 = .402$.

The initial pressure shown by this diagram, measured from the atmospheric line is 92 pounds, and as the engine is located near the sea level, it is proper to assume that the atmospheric line is about 15 pounds above a perfect vacuum, therefore the real initial pressure of this diagram is 107 pounds, and $.402 + 107 = 43$ pounds, from which must be subtracted the back pressure of 17 pounds, showing that the mean effective pressure is 26 pounds.

The back pressure is determined by assuming that the atmosphere causes 15 pounds, and the diagram shows 2 pounds.

Here then is a case from every day practice, where the mean effective pressure found by the planimeter is 30 pounds and when determined by rule it is 4 pounds less, which is about as near as we can expect them to agree. The difference is due to the fact that the expansion line is higher than correct theory

calls for. This is caused by a slight leak in the steam valve, or by re-evaporation of water in the cylinder as the pressure on it grows less.

The point to be emphasized in this connection is that neither 26 nor 30 pounds is the mean pressure, or the average pressure on this piston, notwithstanding the fact that it is so often claimed to be, as already mentioned.

In cases where the counter-pressure line and the atmospheric line of a diagram are in the same place, the real back pressure is about 15 pounds at sea level (and less as the engine is located on higher ground), consequently the real forward pressure is 15 pounds more than is indicated by the height of steam and expansion lines, above the atmospheric line. Another point which seems to be lost sight of in this connection is that during the time that the steam and expansion lines are being drawn, there is no connection between that end of cylinder, and the part on which back pressure is acting.

Now the mean effective pressure acting on a piston is the

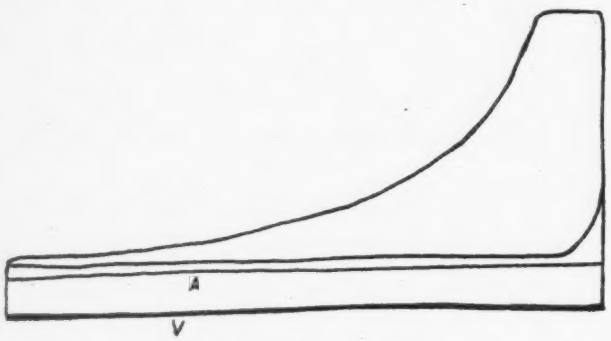

Fig. 2

forward pressure minus the back pressure, but the average pressure does not take into account the back pressure in any way or form, consequently, when we are told to use the average pressure on the piston, to determine the indicated horse-power, somebody has made a blunder.

Fig. 2 is a reproduction of Fig. 1, with a few more lines added. A is the atmospheric line and V the vacuum line. The average pressure indicated by this diagram is found by starting the planimter at 2, coming straight down to the vacuum line, following it to the end of diagram at the left, then upward to the expansion line which is followed back to the steam line, and thence to the starting point.

The result is an average pressure of 47 pounds. This is consistent, because the mean effective pressure as found by the planimeter is 30 pounds, the counter-pressure and the atmospheric lines are far enough apart to denote 2 pounds, the atmospheric pressure is 15 pounds, and 30+2+15=47 pounds.

We will now proceed to find the average pressure of this diagram by rule, the same as we did the mean effective pressure. The ratio of expansion is 7.5, the hyperbolic logarithm of which is 2.0149, and adding 1 to it gives 3.0149. Then 3.0149 ÷ 7.5+107=43 pounds average pressure.

The difference between planimeter and rule is 4 pounds on the average pressure, the same as it was for the mean effective pressure, which affords further good illustration.

I have mentioned the fact that the mean effective and the average pressures would be the same in a condensing engine provided a perfect vacuum is maintained in the exhaust pipe. If this could be done the planimeter might be run over the diagram, in the way already described for Fig. 2, and in that case the average and the mean effective pressures would be the same, but until this is accomplished we should recognize the fact that they are not, and use each in its proper place.

The mean effective pressure is used to determine the indicated horse-power of an engine, therefore its place is well known, but some reader may ask what the average pressure is used for, and to this I reply that it is proper to use it for the purpose of determining the total load on an engine, therefore it should be used much more than it is.

For an illustration of the utility of it, suppose that we calculate the total load on an engine under different conditions, and compare the results. The area of cylinder from which Fig. 2 was taken is 615 square inches, and assuming the piston speed to be 500 feet, the total load amounts to 615x74x500÷ 33,000=438 horse-power.

If we proceed to add an independent condensing apparatus and get good results from it, the average pressure, using the term advisedly, will be reduced 12 pounds, because 12 pounds of back pressure will be removed, thus allowing the governor to reduce the average pressure by an equal amount.

The total load on the engine then is 615x(47—12)x500÷ 33,000=326 horse-power. As the total load is so much less, the coal required to run the engine is less accordingly, or nearly so, and there is no mystery about it. This statement of the case is much superior to the claim that adding a condenser increases the power developed which is not true.

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Discoveries Which Prove the Great Inferiority of Modern Civilization.

Thousands of years ago, it is claimed, there existed in New Mexico a system of reservoirs, irrigation and viaducts that is unparalleled at this age. This is proven beyond a doubt by discoveries and investigations that have recently been made. Under the lava which covers hundreds of square miles are found traces of cement ditches and reservoirs that are marvels of engineering.

In those days, says *The Rural Californian,* the deserts bloomed like a garden and a civilized race of millions occupied the arid Southwest. Our irrigation engineers have much to learn from the people older than the Pueblo race, who inhabited New Mexico when the race from which Columbus sprang were still barbarians. In those days reservoirs at convenient basins stored the water, which was led in cemented ditches across the loose soil to where it was needed for use. Chasms were crossed by viaducts. Into some of the ditches lava has run, showing their great antiquity. Others are covered with shifting sands, but enough are visible to enable skilful engineers to understand the system which modern civilization with its boasted attainments, has been incompetent to construct.

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In making valve attachments see that the valve closes against the steam pressure.

LETTERS FROM ENGINEERS

In order to make this department of THE PRACTICAL ENGINEER as interesting as possible, a moderate rate will be paid by us for all contributions published under this heading. However, we do not assume responsibility for the ideas or opinions expressed. None need hesitate to contribute because of inability to draw or write well. We will redraw or revise whenever necessary—it is the idea we want. New ways of doing old things, criticisms of accepted theories and general engine room experiences are especially solicited.

Worth the Price.

Editor The Practical Engineer:—

Your April issue contains a letter from Supreme Treasurer Richardson congratulating you upon the improved appearance of The Practical Engineer. Brother Richardson says further that he is a reader of many periodicals but that he considers The Practical Engineer the best paper in the world for the price.

A statement like this coming from a man of Brother Richardson's high standing in the mechanical field, deserves the consideration of every engineer. I have been one of its readers from its origin and I can truthfully say that the knowledge which I have obtained from its columns has been worth many times the subscription price.

FREDERICK MARKOE,
Grand Corresponding Engineer.

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Another "Slack" Economizer.

EDITOR PRACTICAL ENGINEER:

I have carefully looked over the article "A Practical Home-made Economizer" appearing under the head of Letters from Engineers, in your issue of February 1st, 1902, by Harry Slack. I do not have a copy of the February number of the "Practical Engineer" and I cannot of course know just what style of an economizer a reader furnished your paper, but in studying carefully Harry Slack's drawing I cannot say that I would recommend it to engineers, especially this exact method of utilizing the heat units going up the stack.

We all know that if these heat units can be utilized, it is that much saved, for it would otherwise go to waste. I doubt very much that Harry's method would work satisfactorily, and if Harry does recommend this system of heating feed water, why would he necessarily have to have the large iron closed tank? This tank must necessarily be a closed stout tank, sufficient to withstand the water pressure and of the highly heated water after it has been through the heated coils in the stack. Taking his idea as he presents it, suppose he must stop his pump for some 25 to 30 minutes the water in the tank and coils must necessarily get very hot and create quite a pressure through the entire system, then when his boilers for water again he goes to start his pump I imagine he would have a happy time pumping this extremely hot water through his pump into his boilers. All engineers know that a pump has a limit as to how hot water it will pump (especially so like "Harry" has shown, for he has not introduced any means by which he could pump this hot water).

The writer has had some experience with these "Home made economizers" and he does not believe Harry's system will do, that is, if he wishes to retain his religion. If Harry Slack would completely reverse his apparatus and let the city water flow into his pumps instead of the tank, (and do away with the tank) and then pump this cold water through the coils in the stack and then directly into the boiler, he will find that the system will prove much more economical, and I-twould, as stated, do away with the tank, it is a useless addition.

Why I say this system would be more economical is, because you can have as many coils in the stack as it will admit of, so as not to interfere with the draft and in reaching the tubes you could heat the water to 212° Fah. or much higher and immediately rush it into the boiler, but by Harry's method even if it would work there would necessarily be a loss in heat units in the feed-water more so than with the system I recommend. Why—simply because the hot water or feed to his pump must be drawn from the pipe "D" and by the time it went through the pipe to the pump and then back to the boilers it is needless to say there would be a noticeable drop in the temperature. Then too in the system I recommend if there should happen to rise a very high pressure in the system above boiler pressure it would raise the check on the feed pipe and enter the boiler. The writer has seen back systems tried and I would much prefer the latter, that is, let your cold water go to your pumps, and pump it through the coils, adding the necessary number of coils suitable to raise the water to the required or desired temperature. Copper coils are the most preferable, but good iron pipe coils last reasonably well to insure quite a nice saving when no other more preferable method is used in raising the temperature of the feed water.

A STOKER.

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The Effect of Ammonia on Metals.

Answers to questions 4 and 7 asked by the Educational Committee of the A. O. S. E. in the January number of "The Practical Engineer."

DEAR EDITOR:—In reading the letter from Harry W. Sherman, of Wilmington, Del., I notice that his ideas are different from mine, so I will give mine, and perhaps we can wake up some Brother Engineer who can tell us which is right. Ques-4. What effect has anhydrous ammonia on metals such as steel, iron, brass and copper?

Ammonia has a very strong action on copper and alloys. No part of an ammonia apparatus with which the ammonia is liable to come directly in contact should be made of copper, brass or bronze, as such metal is rapidly eaten away, while it has no effect on steel or iron.

Ques. 7. Name the different parts connected with the absorption system. What kind of ammonia is used in this system? Explain the operation of the absorption system.

1. Generator with analyzer and heaters.
2. Condenser.
3. Receiver.
4. Cooler.
5. Absorber.

6. Ammonia pump; and if an ice plant the 7th would be a brine tank.

The ammonia used in the absorption system is 26° degrees ammonia or aqua ammonia, which consists of water with about 10 per cent. of ammonia gas. Its strength is *26° Beaume*, and is called commercial liquid or 26° ammonia.

The condenser used may be either of the submerged type or the atmospheric type. The latter type is recommended where the water supply is limited. As to the operation of the absorption system I will say that to do the matter justice would take take up much space, so I will give that of the operation in an ice plant of this kind.

The ammonia pump is the only mechanically operating part of the plant outside of the boiler room where the usual feed pump may be found. The duty of the pump is to pump the strong aqua ammonia from the absorber to the generator. The mediums used are water, brine, steam and ammonia. The brine is used in the freezing tank as a medium for transferring the heat from the freezing cans containing the water to be frozen to the expansion coils. One branch from the water supply carries water to the upper part of the distilled water cooler, in which the distilled water is cooled to about 90° F. Another branch of water passes to the ammonia condenser for cooling purposes, from which it passes to the weak liquor tank for further duty in cooling. Another branch of water is taken from the mains by the feed pump and forced through the feed water heater, heated by exhaust steam from the generator heating coils to the boiler. The steam from the boiler passes to the heating coils of generator, thence through the feed water heater to the upper part of the distilled water tank, where it is cooled by water, as stated above, to 90° F. From the upper part of the distilled water cooler it is passed to the lower part where it is reduced to a low temperature by the coils with the return gas from the expansion coils on its way to the absorber from the distilled water cooler.

The condensed steam is passed through a charcoal filter to the distributing pipes for supplying the freezing cans. As the steam used in the generator is not sufficient to supply the distilled water required for the ice, live steam is fed directly from the boiler to the distilled water cooler to make up the deficiency. The course of the ammonia may be easily followed by beginning with the strong aqua ammonia formed in the absorber by the union of the weak liquor and the anhydrous or ammonia gas.

From the absorber the aqua ammonia is pumped through the equalizer to the upper part of the stand pipe of the generator. The weak liquor passes from the lower part of the generator through equalizers to the weak liquor tank. From this the weak liquor is admitted to the absorber on automatic regulators used for regulating the flow of the weak liquor to the absorber and is an important adjunct to the system.

The anhydrous ammonia produced in the generator passes out at the top of the stand pipe of the generator to the ammonia condenser, where it is condensed to the liquid form from the ammonia condenser. The liquid anhydrous ammonia is admitted by an expansion valve to the expansion coils where it assumes the form of gas. There coils are properly arranged in the brine tank for cooling the brine and thus indirectly freezing the water in the freezing cans. From the expansion coils the anhydrous ammonia, now in the form of gas, passes through a cooling coil in the lower part of the distilled water cooler to a final completion of the cycle by entering the absorber where it is again united with the weak liquor to form strong aqua ammonia.

As no oil is used in the system the steam may be passed from the generator where it does its work direct to the cooler without extensive cleaning apparatus.

The weak liquor spoken of is what is left of the strong aqua ammonia after passing through the generator and out at the lower part of the generator, while the anhydrous or gas passes out at the top.

READER.

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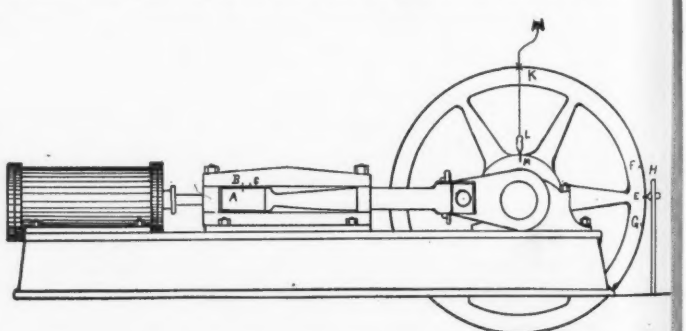
Method of Placing Engine on Dead Center.

Editor PRACTICAL ENGINEER:

I have discovered what appears to me an original and unique plan for quickly and accurately placing an engine on the dead center when certain measurements and points are established and permanently marked. Every engineer knows that the best manner to find the dead center is to fix an upright standard to the floor with an index or pointer attached as at H, so as to touch the outside rim of the fly-wheel. Place the crank so near the center that the crosshead shall have completed the stroke to within an inch or inch-and-a-half and make a mark on the crosshead shoe at A and a mark on the upper guide at C to coincide with mark A. With the engine setting in this position make a mark on the rim of the fly-wheel where the index H will point and this will be indicated by G. Then turn the engine so the crank shall pass over dead center until the mark A on the crosshead shall again coincide with mark C on the upper guide and then make another mark on the fly-wheel rim at the index of F.

With a pair of dividers find the center between F and G and make the mark E, then turn the engine back till the mark



E coincides with the index H, when the crank will then stand on the exact dead center. This procedure requires considerable time and in case one wishes to place his engine on the dead center quickly much time is required in so doing. While the above is a necessary preliminary to finding the dead center and with the engine standing in that position I would suggest that making a mark on the edge of the fly-wheel at K perpendicular to the center of the shaft, and from that point drop a plumb line and where the point of the plumb bob strikes the hub of the fly-wheel make a center punch mark indicated at M. It will be seen very readily that if the rim of the fly-wheel be moved even a 1-6 of an inch the point of the plumb box will also be moved a certain distance from the mark on the hub of the wheel at M, and I believe these marks will ever afterwards serve as a guide for accurately setting the engine on the dead center in almost a moment's notice.

As the crank and fly-wheel of every engine is securely keyed to the shaft the permanency of the marks will not be or could not be destroyed with relation to their different position. As I have never seen that plan used or read of a kink, I give it to my brother engineers for what it is worth.

Washington, D. C. HENRY M. STATZ.

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Brief History of Steam Engines.

The earliest notice we have of heat engines is found in the Pneumatics of Hero of Alexandria, about 130 B. C. From that time to the seventeenth century there is no progress to record.

The next distinct step was the publication in 1601 of a treatise on Pneumatics by Porta, in which he shows an apparatus similar to that of Hero's, but with steam instead of air as the displacing fluid. But to Edward Somerset appears to be due the credit of making the first useful steam engine. This was about 1663. The first one to make commercial success of the steam engine was Thomas Saverg, in 1698.

In 1690 Denis Papin suggested that the condensation of steam should be employed to make a vacuum under a piston previously raised by the expansion of the steam.

Papin's was the earliest cylinder and piston engine, and his plan of using steam was that which afterwards took practical shape in the atmospheric engine of Newcomen.

In 1769 James Watt patented improvements, the principles of which to this day guide the development of the steam engine.

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Largest Belt in the World.

One of the largest belts for machinery that has ever been produced was recently finished by the Gutta-Percha and Manufacturing Company, Toronto. The belt was of rubber, and measured 3,529 feet in length, over two-thirds of a mile. Its weight was nine tons. This mammoth belt was made for the grain elevator of the Inter-Colonial Railway at St. John, N. B., and is now in use there.

The Myers Transportation Company, of Pittsburgh, Pa., has been incorporated to build, operate and equip airships and to engage in business of transporting passengers through the air. The authorized capital stock is $100,000.

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Asks $10,000 Damages.

Herman Rudolph of Grant's Pass, Oregon, has sued the Booth-Kelley Co. of that place for $10,000 damages for injuries received in a boiler explosion while in the employ of the company at Saginaw, May 2, 1900. The plaintiff alleges that the boiler was defective and that this fact was known to the company before the accident.

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Know a Good Thing When They See It.

Editor THE PRACTICAL ENGINEER:

I sent you the names of seven new subscribers two weeks ago, with $3.50 in payment of the same. I now have ten or twelve more, and could get a hundred if I had the time. I don't have to ask an engineer to subscribe, just show him a copy of THE PRACTICAL ENGINEER and I get the fifty cents.

H. MADDOX, Morriston, Fla., 4-19.

QUESTIONS AND ANSWERS.

THE editor will be glad to receive from the readers of THE PRACTICAL ENGINEER, such questions relating to engineering subjects, as may, from time to time, occur to them. All questions and answers should be addressed to the editor and accompanied by the name and address of the writer, which will not be published, however, unless especially desired. It is the intention that questions shall be answered by the readers, and even though the editor may, from time to time, publish answers with questions, he especially desires the readers in such cases to contribute any further information in connection with the points raised, that they may consider of interest. All questions and answers received by the editor will be published, as far as practicable, but he reserves the right of editing or rejecting any communications.

Editor PRACTICAL ENGINEER:

I would be pleased to have the opinion of some of your readers upon the following conditions found in my engine: I have charge of an eighteen hundred horse-power slide-valve engine; in resetting the valves I noticed when I took the bonnet off and placed the engine on dead centre that I had a lead of 3-16 on one end and 7-16 on the other end. The jamb nuts were hard up against both valves (it is a double slide). I would be glad to learn how this could happen with the jamb nuts tight.

E. E. McCOY, Chester, Pa.

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Editor PRACTICAL ENGINEER:

Will you please inform me through the columns of your paper where I could purchase roller bearings. I would like to get them for a small machine I am making.

B. E. ADAMS.

Following are the names of the leading roller-bearing manufacturers of this country. Standard Roller Bearing Company, 2336 Market street, Philadelphia, Pa., American Roller Bearing Company, Binford street, Boston. Mass., American Ball Bearing Company, Cleveland, Ohio.

Probably the Standard Company would come nearer having what you need than the others, as they make a specialty of bearings for small machinery. EDITOR.

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Editor PRACTICAL ENGINEER:

I have an oil tank of the following dimensions:

Bottom diameter, 8′ 5″

Top, 7′ 6″

Heighth, 5′ 2″

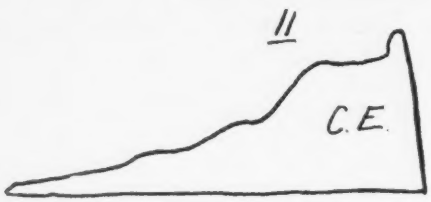
Will you please give me through your columns a scale by inches the number of gallons of crude oil in the tank.

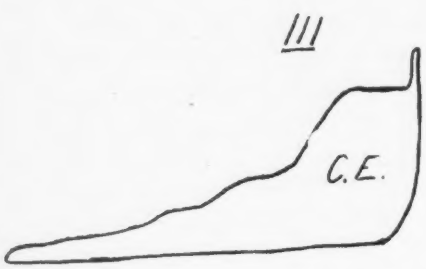
J. LUTHER.

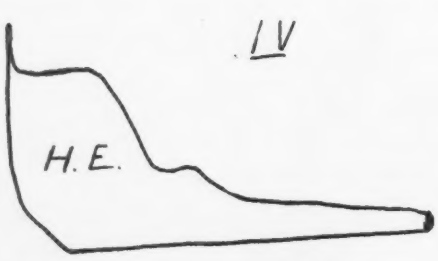
The volume of the tank mentioned, which is shaped like the frustrum of a cone, that is a cone with the top cut off, is found by first taking the mean diameter, that is, the average diameter of the top and bottom. This we find to be 8′ 1″, or 97″. We next find the area of this middle section, according to the formula: Area equals the square of the diameter, multiplied by 3.1416. The square of 97 is 9409, and this multiplied by 3.1416 equals 29,559.3144 sq. in. Multiplying this by the height, 5′ 2″, or 62, reduced to inches, we get 1,832,677.4928 cu. in., and dividing by 231, the number of cubic inches in a gallon, we have 7,933.2-3 gallons as the capacity of the tank. To prepare such a scale as you request, it would be necessary to work out similar problems for each inch in height, as far as you desire the scale to run. EDITOR.

Editor PRACTICAL ENGINEER:

Enclosed you will find diagram of Buckeye Engine 9x14, 260, rev., per. m., 80 lb. boiler pressure. This engine has been in use about 15 years, driving a Westinghouse generator; lately it has become necessary to put an additional load to the engine and it failed to do the required work, giving considerable trouble. The indicator was applied and diagram I and II







was taken. After setting the valves by the indicator, diagram III and IV was taken. The engine seems now very quiet and does the required work.

The Corliss engine, from which the other diagram was taken, is a 16x36, making 90 rev. per m., boiler pressure 80 lbs., engine pounds on head center. Please tell me what to do to better conditions.

2. Please give me a rule for finding the temperature of steam when the pressure per lb. is known.

3. In figuring the water consumption from an indicator card, some give the following rule: Add the percentage of clearance to the portion of stroke completed at release, and so forth. What I wish to know is do they mean a certain per cent. of the cubical contents of the cylinder or what else do they mean?

3. On a centrifugal pump I have the vacuum created by a steam pipe which was screwed in on the top of the same. The steam was used, I imagine, to draw, by the sucking force it possesses, the air out of the pump, the vacuum gauge showed 50 lbs. I do not understand how a steam jet which discharges free into the air can create a vacuum of 50 lbs., the suction pipe being under water. The pumps were used for dredging purposes. Will you kindly give me some enlightenment in regard to the above?

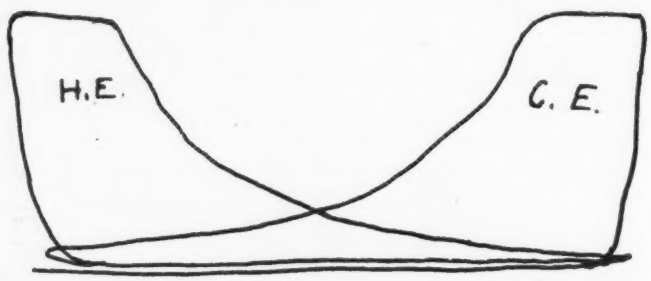
Thanking you in advance for favor, I am,

Yours respectfully,

L. J. STIFF, Texas.

The change made in the set of the valves of the Buckeye engine undoubtedly increased your power greatly, you were losing a large percentage of power through the exhaust being still open when you began to admit steam. The cards III and IV show that this has been properly remedied. The tail shown on the cards III and IV is due to the pencil fling. With an engine running at the speed mentioned you cannot obtain much better results except that you might reduce the cut-off a little more on the head end.

Concerning the pounding of the Corliss engine: It is impossible to detect any defect in the card shown that would lead to the discovery of the cause. It may occur from a loose wrist



pin; if running understroke it would thump on one end, if running overstroke it would thump on the other.

Again, if it is a keyed crank it would thump on crank center only, if loose. If it is a screwed crank with Jamb nut and it should become loose it would thump on head center.

2d. To thoroughly elucidate the question asked would require more space than our Question column permits. We refer the readers to the following table which was compiled after an exhaustive experiment along this line, and also to the PRACTICAL ENGINEER of June, 1898, in which there is a very lengthy and comprehensive article on this subject.

TABLE OF PROPERTIES OF SATURATED STEAM.

Total Pressure per Square Inch. LBS.	Temperature in Degrees F. FAHR.	Total Pressure per Square Inch LBS.	Temperature in Degrees F. FAHR.
1	102.1	75	307.5
10	193.3	90	320.2
14	209.6	105	331.3
14.7	212.0	120	341.1
15	213.1	135	350.1
18	222.4	150	358.3
21	230.6	180	372.9
24	237.8	210	386.0
30	250.4	240	397.5
36	260.9	270	407.9
45	274.4	300	417.5
60	292.7		

3d. In figuring the water consumption from an indicator card and the meaning of the rules in the matter of either

cubic or square inches, it would depend entirely upon the method of figuring. If you figured the volume certainly the contents would be cubical, but if you figure by inches in the ordinary term you would mean inches.

4th. You had better throw the gauge you have away. It is certainly radically wrong ; the conditions are an impossibility. The highest possible vacuum for you to obtain would be about 14 7-10 pounds. EDITOR.

✣ ✣ ✣

Foaming.

In case of foaming close the throttle or stop valves and keep them closed until the water becomes quiet and shows its true level. Foaming, if caused by dirty water, can usually be stopped by blowing off and adding fresh water. If the boiler primes, lower the water line for a time.

The possibilities of steam power can in a measure be realized by the following :—During the recent big fire at Atlantic City it was seen that outside help must be had to successfully cope with the flames, and an appeal was made to Philadelphia for engines. In thirty minutes after receiving the notice the Philadelphia authorities had three engines with complete equipment upon the train at the Reading R. R. station in Camden. From there the run to Atlantic City is fifty-nine miles; the train was exactly 37 minutes in making the trip. A speed of 92 miles per hour being maintained.

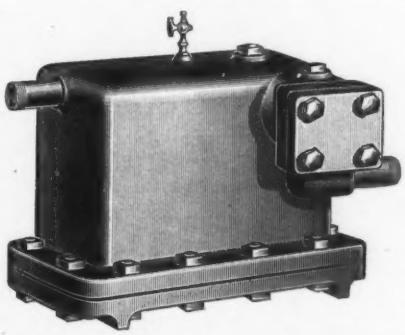
✣ ✣ ✣

The Powers Steam Trap.

The direct value of steam traps cannot be over estimated when considering the application of steam specialties to the boiler or engine room ; thus it only becomes a question to decide which will be the best device of the kind manufactured for that purpose ?

In considering this quesiton it will be well to see that the trap is free from all possibility of the float water "logging" or collapsing ; that the discharge valve is both easy of access and free opening and also free from danger of leaking.

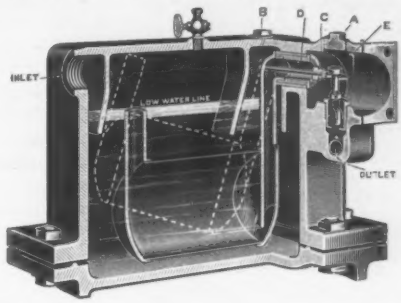
We give herewith a description of the Power Steam Trap,



manufactured by the Direct Separator Company, Syracuse, New York, which is sure will commend itself to the reader after a careful study of the construction be made.

The object in designing the Powers Steam Trap was to produce one that should have a perfectly tight valve when filling, leaking neither steam nor water ; that should be powerful enough to open quickly, and positively a valve of liberal size, and never suffer from a collapsing or "watter logged" float ;

By referring to cut you will notice the water enters at point marked inlet, filling the trap to the top of the tube leading to the bucket, then the bucket begins to fill, and as it starts downward it is flooded by the water accumulated and goes to the bottom quickly, opening the outlet valve when it reaches a point where the bucket is full ; while the valve is open, one-half the water in bucket and the water in trap between point A and the top of the trap passes out, after which the water in trap between A and the bottom floats the bucket up and closes the valve, when the above operation is repeated.



Emptying only one-half the contents of the bucket leaves the outlet water sealed, the seal being in the form of a U in the bucket, and from A to bottom of partition in trap ; the reserve space in bucket added to that in trap is larger than in many, if not most other traps. While balance valves may give a larger opening, many have a small leverage effort and do not accomplish more, and more of them leak, which is an expensive way of doing it. Our idea in producing an intermittent trap is that it will not wear away the valve and leak.

The bucket, outlet pipe and valve are made of brass; the valve is arranged so it will rotate every time the trap empties, insuring a perfect seat ; the case is of cast iron with a liberal margin of safety for the pressure intended, which should be given in ordering. A large plug is placed opposite valve so that it can be reached without disturbing connections, a smaller plug is placed in line with valve so that the seat can be refaced, if necessary, without disturbing connections or cover. The arrangement should insure all sediment being caught before it can reach the valve.

✣ ✣ ✣

Why They Change Engineers.

In the vicinity of Ninth and Filbert Streets, Philadelphia, there is a concern that has changed engineers quite frequently during the past year or so. Upon inquiring the cause of one who recently vacated the job we were informed that the plant itself is sufficient to occupy an engineer's whole time, but that it is the custom of the proprietor to place a memoranda on the engineer's desk every morning setting forth the additional duties expected of him during the day. Copies of some of these follow :

March 8. Fix leak in bulk window. Fix gutter for oyster bar. Fix scoop for pantry. Hook for shutter. New hinges. One lamp in B. 9 St. Fix lock of side door. Look at nuts of restaurant dummy.

March 11. Glue table. Cement urinal. Fix telephone cable. Fix offiice chair. Dummy works hard. Leak in bulk window. New hinges.

March 17. Fix long ladder. Put glass in storm door. Hinges inside. Coil in dishwasher. New hinges. Glue table leg. Edge on pantry table. Lay linoleum in kitchen.

March 27. Lamps 5th floor. Fix dishwasher. Fix a table. Cut down ladder. Fix lock in closet. File screws in kitchen dummy. Fix loose moulding. Fix socket in office dumb waiter. Fix urinal Sunday.

TRADE NOTES.

Lubricating Rotary Valves and Air Pumps are sometimes a vexing problem. The Joseph Dixon Crucible Co., of Jersey City, have a very interesting circular upon the subject, which they will mail upon request.

A neat Circular has just been issued by the Larkin Metallic Packing Co., No. 23 Imperial Power Building, Pittsburg, Pa., describing their self-lubricating metallic packing, which should prove of special interest to engineers having trouble with their packing. The Larkin packing is specially recommended for Corliss valve stems.

The Base-Ball Season is here and the enthusiasts tell us of strong pitchers and graceful curves. The Parker Exhaust Head does not resemble a pitcher, especially the "growler" variety, but it is strong, and it has graceful curves of the kind and style that will appeal to your mechanical judgment. They are manufactured by T. T. Burchfield Co., 619 Arch St., Philadelphia.

Metallic Packings are in greater favor this year than they were last year, and they were more popular last year than ever before. Proven economy, not only in cost of packings, but in friction, lubrication, shut-downs, labor of repacking, and many other ways, is responsible for this increasing demand. Thos. Walker & Sons, 4619 Tacony St., Frankford, Philadelphia, are among the oldest manufacturers of metallic packing, and the fact that their factory is compelled to run night and day to fill orders is proof of the value of their packing.

Frank L. Patterson & Co., 23 Dey St., New York, or Girard Trust Building, Philadelphia, are specialists in Feed-Water Heaters and Exhaust Heads, and can make it very interesting for any of our readers who are contemplating the purchase of either of these specialties.

Many devices have been made for cleaning boiler tubes, but it is doubtful if any have had so large a sale or given such general satisfaction as the Turbine Cleaners made by the Liberty Mfg. Co., 5988 Centre Avenue, Pittsburg, Pa. These cleaners do good work, and with proper care will last a lifetime; moreover, the first cost is small. The makers will send you one for free trial.

Cut out the last page of this paper and send it to Geo. W. Lord, 2238-2250 North Ninth St., Philadelphia with a sample of the scale from your boiler and he will analize it and tell you of what it is composed and how to get rid of it, free of charge.

Keeping flues clean is usually a disagreeable bit of work which contributes about as much to the world's output of profanity, as any other influence of the boiler room. Therefore, in the interest of morality, if not to aid the engineer and save fuel, every steam user should provide the best tools obtainable for doing this work. The Pilley Expansian Brush and Pilley's Combination Flue Brush and Scraper cost but little, save much, and are pleasant to handle. They are manufactured by the Pilley Packing and Flue Brush Mfg Co., 308 North Main St., St. Louis, Mo.

A Good Catalogue of steam specialties is always a valuable addition to an engineer's library, and when we find so many excellent ones to be had for the mere asking, it is passing strange that so many engineers are to be found without them. The latest product in this line is a very handsome new catalogue just published by the Penberthy Injector Co., Detroit, Mich. This catalogue contains upwards of a hundred illustrations, representing the best product of the engraver's art, together with comprehensive descriptions of the specialties made by this Company, including Penberthy Injectors, the Irwin Steam Ram, Low and High Water Alarm, Success Valve Drip Automatic Water Gauge, Round and Square Body Water Gauges, Compression Gauge Cocks, Valves, Lubricators and a complete line of Oil and Grease Cups, with tables of sizes, price lists, etc., all of which are invaluable to the engineer. A copy will be sent free upon request to any reader of THE PRACTICAL ENGINEER.

If you do not know G. E. Hubbert, of No. 123 North Fourth St., Philadelphia, and all about that Stephenson Bar Belt Dressing that he is giving away, it would be a good idea for you two men to get acquainted, either by personal contact or correspondence.

The superiority of France Metallic Packing, it is claimed, has been demonstrated in the recent competitive tests with metallic packings. After a competitive test it has been adopted by the Metropolitan Street Railway Co., New York, for their eleven 7000-horse power engines; New York Gas and Electric Company, for their eight 7500 horse-power engines; Brooklyn Edison Company, for their two 7000 horse-power engines; Boston Elevated R. R. for their two 7000 horse-power engines; and the New York Central and Hudson River Railroad for their stationary work. It is also used in equipping the Manhattan Engines in their large power house in New York city, in addition to several other large contracts. A booklet on packing can be had by addressing Mr. A. W. France, 6500 State Road, Tacony, Philadelphia.

Jas. L. Robertson & Sons, of New York, received an order under date of March 31st, from Mr. W. E. Goldsborough, Director of Dubuque University, of Lafayette, Ind., for six improved Robertson-Thompson Indicators. Mr. Goldsborough is thoroughly familiar with these instruments, and as his practical ability in the use of indicators is unquestioned, no better indorsement of these high grade instruments could be desired.

The Battleship "Illinois" uses as large a size as 1⅜ "Selden" packing, and has recently had some delivered to her by the manufacturer, Randolph Brandt. The fastest Torpedo boats use this packing on their engine rods.

The swift yacht "Arrow" also is packed with the "Selden."

Cross Oil Filters
Do Best

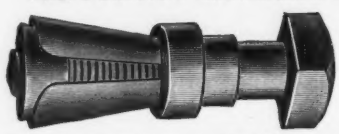
What other filters do well. They clean waste oil and drippings perfectly, making it fit for use over and over again Guaranteed to reduce lubricating oil bills at least 50%.

Nine governments have adopted them. Their sale has reached 28 different countries. They were awarded highest medal at the Pan-American Exposition.

Sold on 30 Days trial Shall we send one?

THE BURT MFG. CO., Akron, Ohio, U. S. A.
Largest Manufacturers of Oil Filters in the World
Cross Oil Filters carried in stock by the
FAIRBANKS CO.,
Sole Agents for Philadelphia

THE POSITIVE EXPANSION BOLT



Special Discount to Jobbers. Write for Prices

Manufactured by D. C. SEAMAN & CO.
1638 Hutchinson St., Philadelphia, Pa.
For sale by Neal & Brinke, 18 Warren St., New York; Somers, Fitha & Todd Co., 323 Water St., Pittsburgh, Pa.

IF ENGINEERS will send $1.00 to the address below they will receive two blue prints, with tables and instructions, showing how to set valves and eccentrics on Corliss engines, simple and compound, with one and two eccentrics. JOHN T. LINDSTROM, 440 Liberty Street, Allentown, Pa.

DO YOU KNOW

That we manufacture chemical water purifiers that are guaranteed to prevent and remove incrustation in steam boilers, no matter what its composition may be.

CHEMICAL PURIFIERS

that do this without injury to the boiler, its fittings or connections;

CHEMICAL PURIFIERS

that can be used with perfect safety in Breweries, Ice Plants, Dye Works and all places where the water of condensation is used for any purpose.

Write for terms, reports, circulars, etc. We interest you and pay liberal commission. Agents wanted everywhere.

THE PEERLESS SPECIALTY CO.
1720 N. 5th St. and 1711 N. Randolph St.
Philadelphia, Pa.

The Cherry Chemical Co., 1215 Filbert St., Philadelphia Pa., manufacturers of the Red Seal Boiler Compound, state to us that their sales for the past three months have been the largest in the history of their business.

They have received testimonials from many of the largest steam users in the country stating that the Red Seal Boiler Compound is the best they have ever used.

This Company Manufactures a number of qualities of compound, and can therefore furnish an artical suitable for all waters.

We Have A Letter from H. B. Underwood & Co., 1025 Hamilton St. Philadelphia as follows:

We take pleasure in writing you these few ines to let you know that we are still rushed with work; in fact, we have been obliged to turn considerable work away, something which we have not done for a number of years before.

We are making a great many St. Johns Self Adjusting Cylinder Packing. This style of cylnder packing has stood the test over fourteen years running, and they are better like to-day than they ever were before. We find engineers want the best article, and they know when they come to us they will get it.

We still have enough of the little books for engineers to supply all the demands, and will be pleased to furnish them to any of your subscribers who care to take the trouble to write to us and give their address.

We have not had the pleasure of seeing your Mr. Rice lately, and we hope he will stop in occasionally as has been his custom heretofore; we are always glad to see him.

Mr. G. Frank Duemler has been appointed manager of the eastern branch of the Pittsburg Gage & Supply Co., with offices at 1011 Girard Trust building Philadelphia, Mr. Duemler is an engineer of known ability and a genial good fellow, he will be pleased to have his friends call upon him. If you cannot call write him for his catalogues of steam specialties, and his White Star booklet.

There are some points about the Richards Corliss Engine that appeal very strongly to a practical mechanical engineer and are well worth investigation. Nor are these points experimental ones as the Richards engine has been in service a score of years or more and has gained an enviable reputation among the large manufacturing establishments of Philadelphia where dozens of them are in daily use. It will pay any one needing an engine to see the Richards Engine before buying. For further particulars address Corliss Engine Works, Howard & Huntington Sts., Phliadelphia.

Randolph Brandt, manufacturer of the "Selden" packing, has just returned from a Western trip and reports evidences of prosperity everywhere. The number and sizes of the orders for "Selden" were the largest in his experience.

The Pittsburg Gauge and Supply Co. have received an order for a 6000-gallon multiple connected Duplex type of their White Star Oil Filter. This process possesses a new and distinct feature in oil filteration which is worth investigation, and in order to enable their friends to investigate the system with the greatest possible ease and to comprehend its construction and advantages, the makers have published a special new catalogue showing their Duplex type both in single units and connected in multiple. The illustrations are of the highest order and the descriptive matter is comprehensive and complete. A copy will be sent to any of our readers for the asking. Address 308 Water St., Pittsburg, Pa.

Every User of Power and Light Should Read the

POWER and LIGHTING ECONOMIST

tells where to buy best, how to save money, how to improve methods. Thus $1 may save you $1,000—50c a copy, $1 a year; Frank H. Knox, Troy, N. Y., and all live news-dealers. Read it and be benefitted.

The Key to a Good Sitvation

is a technical education. Great industries require trained workers. Carnegie's partners rose from the ranks. We teach by mail. We have helped thousands to better themselves. A few

FREE SCHOLARSHIPS

in Mechanical, Electrical, Steam, Textile Engineering; Heating, Ventilation and Plumbing—including Mechanical Drawing—will be awarded to early applicants. The only expense is the actual cost of instruction papers and postage.

Handbook describing courses, methods and regular terms on application.

American School of Correspondence, Boston, Mass.

YOUR BELTS

YOU DON'T WANT TO RUN TIGHT BELTS. DO YOU?

YOU HAVE TO. WE KNOW YOU DON'T BELIEVE IN BELT DRESSINGS. WE DON'T BLAME YOU.

BUT YOU WILL BELIEVE IN CLING-SURFACE if you will investigate what it will do.

It penetrates a porous belt and leaves the surface clean—not sticky.

It preserves the belt, stops all slipping, so the belt can run easy under full load. This isn't what we say, it's what our customers say. We will show you if you wish. Get a package, test it, pay only if satisfactory.

CLING-SURFACE MFG. CO.,

185-191 VIRGINIA ST., - - - BUFFALO, N. Y.

NEW YORK—39-41 CORTLAND ST.
PHILADELPHIA—THE BOURSE.

SOMETHING

YOU SHOULD READ

GRAPHITE FOR VALVES AND CYLNDERS

is the title of a little pamphlet that tells of the experience of engineers who have used graphite for better lubrication.

SUPPOSE YOU SEND FOR ONE?

NO CHARGE

JOSEPH DIXON CRUCIBLE CO.

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SALESROOMS AT
68 Reade St., New York City
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PUMPING HOT WATER

Some engineers are disinclined to use an "open" heater because of the trouble which they or their friends have had in getting their pumps to handle water at a temperature of over 150° to 160°. Now, a **COCHRANE HEATER** will deliver water close to 212°, and it is

JUST AS EASY

to put water at this temperature into boilers as it is to feed cold water—and think of the saving, as well as the advantage to the boilers, of a right hot feed which will do away with contraction and expansion strains.

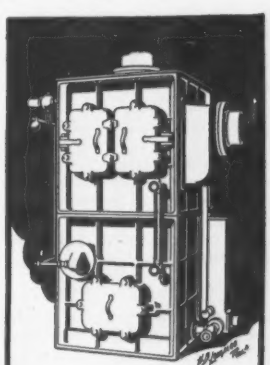
EVERYTHING IN KNOWING HOW

We can put you on to all of the little "kinks" of how to do it without trouble, and without expense, for you must remember that we have the experience that came from installing hundreds of thousands of horse power of these **"COCHRANES"** which are running satisfactorily to-day.

If anyone interested in the subject will take the trouble to write us, stating just how he has connected up his pump, or asking us how to pump hot water, we will take pleasure in telling him, but he runs the risk of hearing something about the good points of our

COCHRANE FEED-WATER HEATERS AND PURIFIERS

Send for "Catalogue 16-H"



COCHRANE HEATER

HARRISON SAFETY BOILER WORKS

3144 North 17th Street, PHILADELPHIA, PA.

American Order of Steam Engineers.

ORGANIZED APRIL 27, 1886.

An Order of Engineesr for Engineers and Engineers only.

DECLARATIONS OF PRINCIPLES

Believing that ability will bring its full value in this country, this Order shall at no time take part in strikes, nor in any way interfere between employer and employees. Recognizing their identity of interests, it shall take no part in any project or enterprise that shall interfere with perfect harmony between them ; neither shall it be used for political or religious purposes.

These principles shall not be amended or repealed except by unanimous vote of the Order.

Any member who shall be guilty of violating the principles of the Order shall be expelled.

OBJECTS.

First.—To promote a more thorough knowledge in its members of theoretical and practical steam engineering.

Second.—To assist members to obtain employment.

Third.—To help the sick, injured and distressed and bury the dead.

Fourth.—To establish a Widows' and Orphans' Fund.

Fifth.—To help members who shall become incapacitated from following the profession to obtain employment suited to their affliction.

Sixth.—To do our utmost to extend the license law throughout the United States.

Seventh.—To establish schools in which our members may study the highest branches of steam engineering.

MEMBERSHIP.

Candidates for membership must be citizens of the United States, of legal age, of good moral character, and sound of health and limb.

Applicants must have at least one year's active service as engineers, and where a license is required they must hold such license.

Applicants must satisfy the Investigation and Examining Committee of the Council to which they apply for admission, as to their character and ability.

No person shall be elected to membership who has been convicted of a felony in a competent Court of Justice, except he shall have been declared innocent after such conviction and shall have received a full and free pardon from the proper authorities.

LIFE MEMBERS.

Engineers who have past the age limit set by the subordinate Councils, may be elected to life membership. They must pass the same examination as to ability and character as an active member, and must present positive proof that they have been in charge of a steam engine at some time in life, for at least one year. They shall be entitled to all the rights of active members, except that they cannot hold office, vote at election or upon a financial question, or be entitled to any of the benefits.

DIRECTORY.

The Publication Committee of "The Practical Engineer" desires that the Corresponding Engineers of all Councils of the American Order of Steam Engineers send the name of their Chief Engineer and their own name and address, together with the time and place of meeting to the Secretary of the Publication Committee immediately after each election of officers. Address J. C. McDowell, Secretary, in care of "The Practical Engineer," 1215 Filbert Street, Philadelphia.

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Supreme Corresponding Engineer.—J. C. McDowell, 1913 South Eighth St., Philadelphia.

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Deputy Supreme Chief Engineer, David J. Stayton, No. 831 West 5th Street, Wilmington.

Wilmington.

Delaware, Council, No. 1, meets every Wednesday at S. E. Cor. Fourth and King Streets. Chief Engineer, W. D. Wyett. Corresponding Engineer, A. E. Deakyne, 406 Lombard Street.

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Lafayette.

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Evangeline Council. Chief Engineer, John B. Lanaier. Corresponding Engineer, W. J. Maynard.

MARYLAND.

Baltimore.

Deputy Supreme Chief Engineer, James H. Stallings, 3032 Dillon Street, Baltimore, Md.

Maryland Council, No. 1, meets 2d and 4th Fridays in Royal Arcanium Hall. Chief Engineer, J C. W. Schrier. Corresponding Engineer, Wm. S. Smith, 116 W. Lee Street.

Energy Council, No. 2, meets every Wednesday of each month in Bauer Hall, Cheaspeak and Elliott Sts. Chief Engineer, Philip A. Kirkwood. Corresponding Engineer, Jos. H. Stallings 3032 Dillon St.

MASSACHUSETTS.

Deputy Supreme Chief for Eastern District, W. E. Packard, Whitmann.

Boston.

Bay State Council, No. 1, meets second and fourth Fridays, at 149 Staniford Street. Chief Engineer, J. F. Cochrane; Corresponding Engineer, W. S. Trofatter, 777 Parker St., Roxbury.

Boston Council, No. 4, meets 2d and 4th Thursday of each month in Templar Hall, 724 Washington Street. Chief Engineer, Harry G. Black. Corresponding Engineer, Wm. T. A. Faulkner, 41 Worcester St.

Brockton.

Shoe City Council, No. 2, meets 1st and 3rd Wednesday evenings in Red Men's Hall. Chief Engineer, Rufus J. Condon; Corresponding Engineer, G. W. Prentice, 19 Brunswick St.

Worcester.

Central Council, No. 3, meets second and fourth Tuesdays, at 566 Main Street (Central). Chief Engineer, Wm. F. Barnes. Corresponding Engineer, J. C. Ryan, No. 5 Hanover Street.

Malden.

Malden Council, No. 7, meets every Thursday evening in Templar Hall, Pleasant St. Chief Engineer, Frank M. Perkins. Corresponding Engineer, Geo. P. Milliken, cor. Mulford and Green Streets.

Orange.

Orange Council, No. 9, Meets 2d and 4th Fridays. Chief Engineer, Chas. Gartrell; Corresponding Engineer, Fred. L. Hale.

Holyoke.

Mount Tom Council, No. 10, meets every Thursday, in Y. M. C. A. Building. Chief Engineer, William Flory. Corresponding Engineer, Theo. W. Crosby. No. 48 Canal street.

North Adams.

Stewart Council, No. 11, meets second and fourth Wednesdays, at Old Liberty Building. Chief Engineer, C. W. Lewis. Corresponding Engineer, T. G. Fillebrowne, 134 River Street.

Rockland.

Old Colony Council, No. 14, meets second and fourth Saturdays in the American Foresters' Hall. Chief Engineer, E. H. Naylor. Corresponding Engineer, James K. Sedgwick P. O. Box, 333, Rockland, Mass.

NEW JERSEY.

Deputy Supreme Chief, F. O. Garrison, Bridgeton, N. J.

Perth Amboy.

Stevens Council, No. 1, meets third Saturday, as Water, near Lafayette Street. Chief Engineer, Lawrence Oliver. Corresponding Engineer, James H. White.

Camden.

Camden Council, No. 3, meets every Thursday evening at N. E. corner 2d and Federal Street. Chief Engineer, S. R. Middleton. Corresponding Engineer, C. H. Pfeiffer, 671 Berkley St.

Atlantic City.

Atlantic City No. 4 meets every Tuesday evening at Merchants, Cor. Atlantic and New York Avenues. Chief Engineer, R. Endicott. Corresponding Engineer, W. S. Price, Haddon Hall.

Bridgeton.

Bridgeton Council, No. 5, meets every Friday. Chief Engineer, David Sellers. Corresponding Engineer, Francis O. Garrison, Bridgeton, N. J.

Millville.

Millville Council, No. 6, meets every Saturday, 7.30 p. m., in G. A. R. Hall, East Main St. Chief Engineer, Geo. Esabel Corresponding Engineer, Lewis Doughty, 604 Mulberry Street.

NEW YORK.

Syracuse.

John E. Sweet Council, No. 6, meets Monday, Room 23, Nottingham Block, East Washington Street. Chief Engineer, John Cunningham. Corresponding Engineer, S. A. Steel, 311 Orange street.

PENNSYLVANIA.

Grand Chief Engineer, Hiram Trout, 1105 North Tenth street, Reading, Pa. Grand Corresponding Engineer, Frederick Markoe, 931 Orianna street, Philadelphia.

Philadelphia.

Welcome Council, No. 2, meets every Friday, in Necterline's Hall, 12th Street above Columbia Avenue. Chief Engineer, Paul Pieling. Corresponding Engineer, L. D. Woodington, 2428 N. Bancroft St.

Kensington Council, No. 3, meets every Thursday, at A. P. A. Hall, Frankford Avenue and Master Street. Chief Engineer Wm. C. Stolt. Corresponding Engineer, Charles Fournier, 3115 Richmond St., Philadelphia.

Southwark Council, No. 4, meets every Monday, at corner of Reed and Eighth Streets. Chief Engineer, Walter Sommers. Corresponding Engineer, J. C. McDowell, 1913 S. 8th Street.

(Continued on page 26.)

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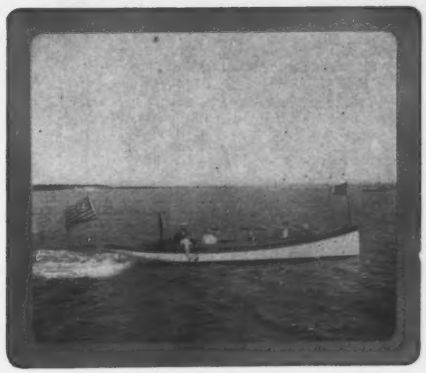

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Manayunk Council, No. 9, meets second and fourth Friday evenings in Temperance Hall. Chief Engineer, Richard Wallace. Corresponding Engineer, John Clevenger, 211 Lofty Street.

Lafayette Council No. 11, meets second and fourth Tuesdays, in Grantz Hall, Main and Manheim Sts., Germantown. Chief Engineer, W. H. Tropley. Corresponding Engineer, James H. Gomersall, 22 Ashmead Street, Germantown, Philadelphia.

Helping Hand Council, No. 12, meets every Tuesday evening at Jasper and Huntington Streets. Chief Engineer, Thos. Evans. Corresponding Engineer, Frank McHugh, 2503 Tulip St.

Municipal P. F. D. Council, No. 20, composed exclusively of engineers of Philadelphia Paid Fire Department, meets quarterly at Girard Hall, Girard Ave. above Sixth. Chief Engineer, Frederick Markoe. Corresponding Engineer, Walter Meyers, 1211 North Howard Street.

Girardville.

Girard Council, No. 8, meets every Tuesday evening at O'Neill's Hall, 2nd and Ogden Sts. Chief Engineer, Jacob Weber. Corresponding Engineer, M. J. Carey, Lock Box 214.

Norristown.

Montgomery Council No. 5, meets first and third Wednesdays of each month at New Red Men's Hall, Main St. above DeKalb. Chief Engineer, L. Purdy. Corresponding Engineer Wm. H. Shainline, Jr., 528 Green Street.

Allentown.

Lehigh Council, No. 15, meets every Wednesday evening at 639 Hamilton St. Chief Engineer, Jacob Donnecker. Corresponding Engineer, A. P. Driesbach, 549 W. 10th St.

Pottstown.

Pottstown Council, No. 14, meets first and third Saturday evening at P. O. S. of A. Hall. corner High and Hanover Sts. Chief Engineer, Joseph Rhoads, Corres., Engineer, H. L. Shirey, 392 Cherry St.

Reading.

Progress Council, No. 13, meets every Saturday evening at Diebert Hall, 9th and Penn Sts., Room 4. Chief Engineer, Frank S. Miller. Corresponding Engineer, James M. Fisher, 1224 Oley St.

Chester.

Delaware County Council, No. 6, meets every Wednesday evening in the Carpenter Hall, 6th and Wall St. Chief Engineer, John Canavan. Corresponding Engineer, E. E. McCoy, 2222 West 3d Street.

York.

York Council, No. 16, meets every Wednesday evening in the Jordan Block. Chief Engineer, F. Seyler. Corresponding Engineer, Walter H. Long, 23 East Philadelphia Street.

Harrisburg.

Capitol City Council, No. 17, meets every Tuesday evening in Red Men's Hall, Market Street, above Second. Chief Engineer, B. H. Shafer. Corresponding Engineer, S. Filson, 1126 Market Street.

Columbia.

Columbia Council, No. 18, meets every first and third Saturdays, in Bittner's Hall. Chief Engineer, R. K. Grosh. Corresponding Engineer, W. J. Courtney, 804 Walnut Street.

Sunbury.

Sunbury Council, No. 19, meets every second and fourth Thursday in Zartman's Hall. Chief Engineer, Aaron Buck. Corresponding Engineer, Ed. Schrieber.

WISCONSIN.

Deputy Supreme Chief Engineer, Joseph P. Harris, No. 1611 Clybourn Street, Milwaukee.

Milwaukee.

Washington Council, No. 1, meets every Saturday at 207 Grand Avenue. Chief Engineer, J. B. Chambers. Corresponding Engineer, James A. Rigby, 136 Reed Street.

Clifford P. Williams Council, No. 2, meets every Thursday evening 298 4th Street. Chief Engineer, David T. Richardson. Corresponding Engineer, Jas. T. Harris, 1611 Clybourn Street.

TENNESSEE.

Deputy Supreme Chief Engineer, John B. Mullen, 826 Central Ave., Nashville.

Nashville.

Enterprise Council, No. 1, meets every Friday evening in the Twin Building on Cedar St. Chief Engineer, J. J. Johnson. Corresponding Engineer, Jno. B. Mullen, 209 Jackson Building.

OREGON.

Deputy Supreme Chief Engineer, Benjamin F. Myrick, P. O. Box No. 1. Grant's Pass, Oregon.

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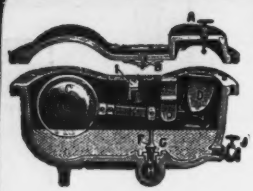
Oregon Council No. 1. Chief Engineer, William H. Kenny. Corresponding Engineer, Benj. F. Myrick-P. O. Box No. 1. Meets every first and third Satar, day. A. O. U. W Hall Main St.



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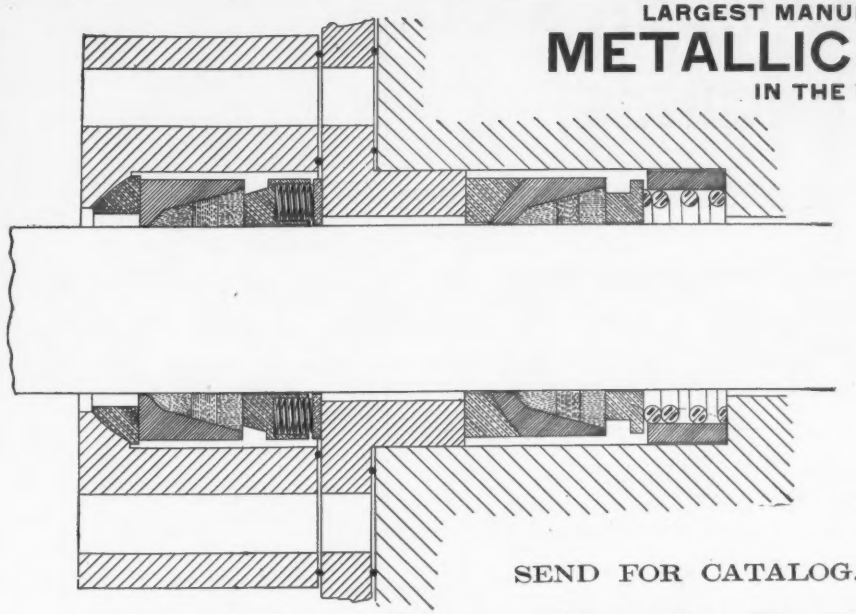

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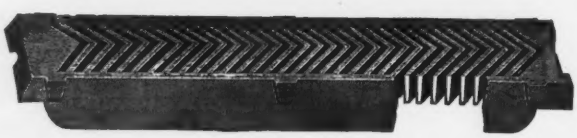

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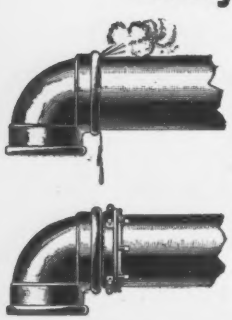

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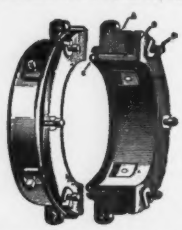

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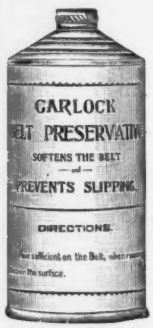

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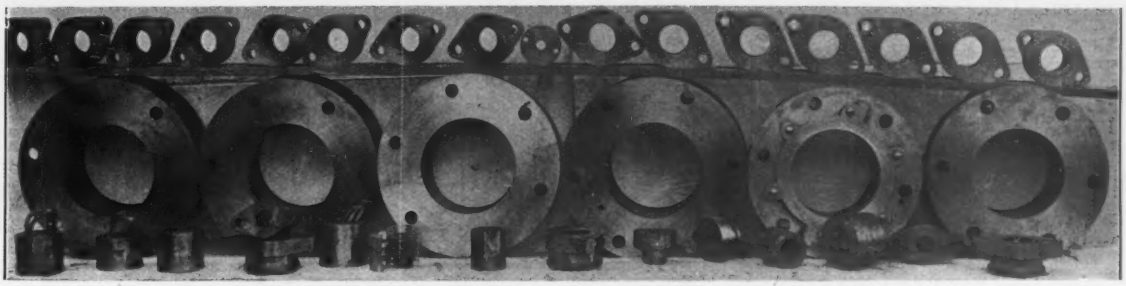

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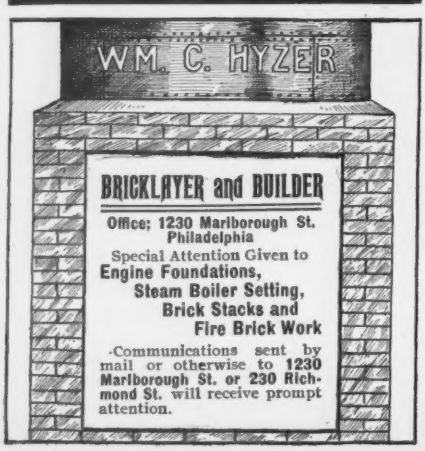
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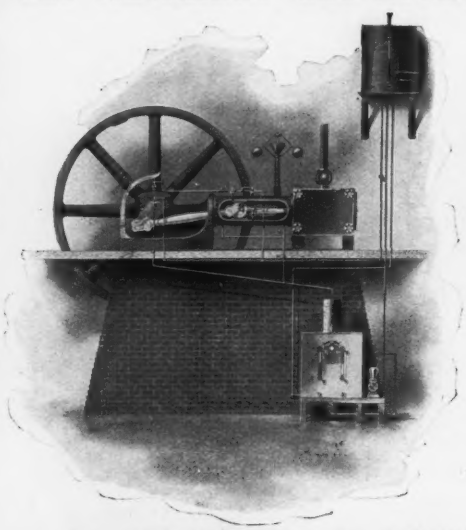

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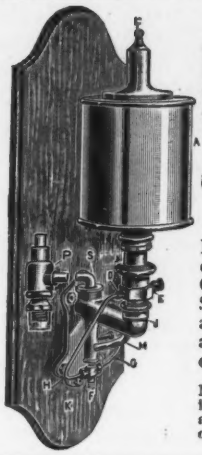

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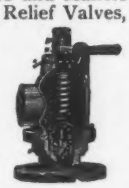

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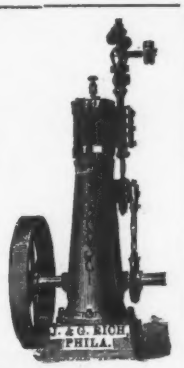

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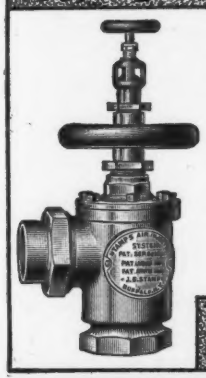

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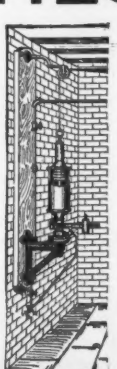

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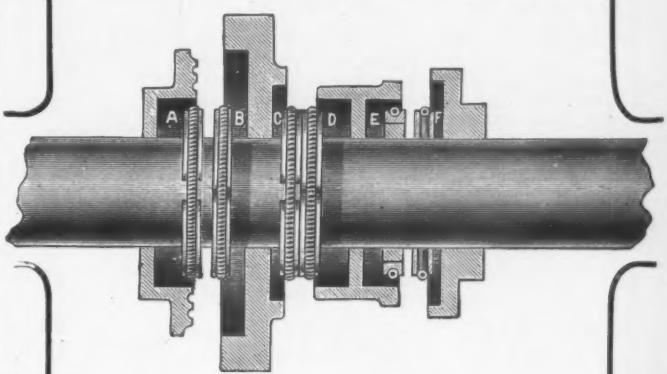

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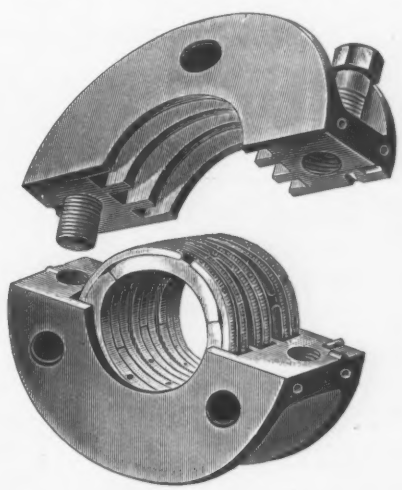

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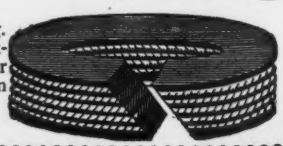

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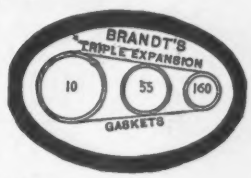

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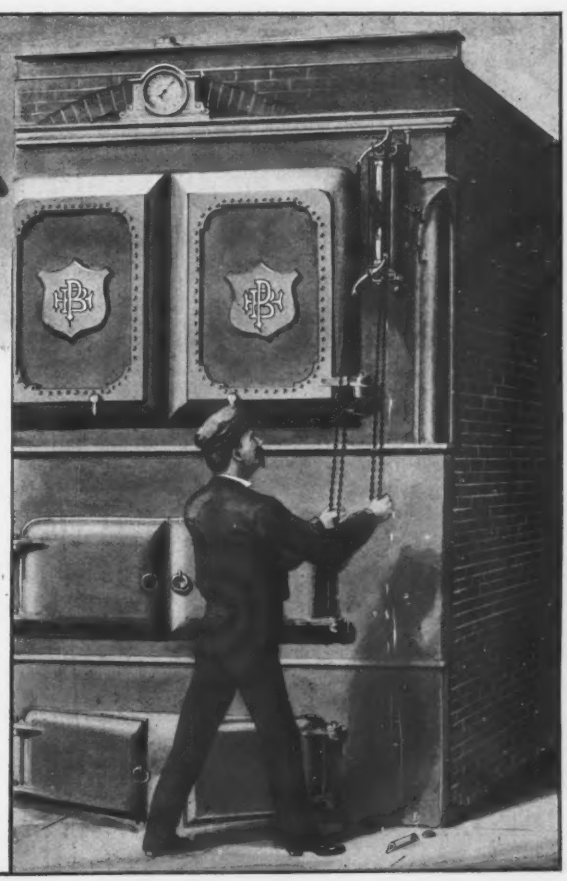

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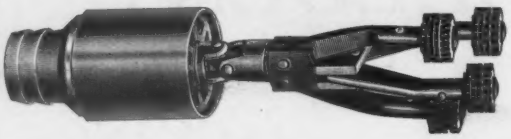

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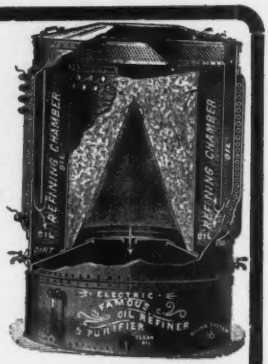

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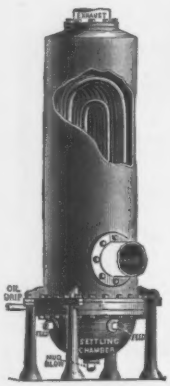

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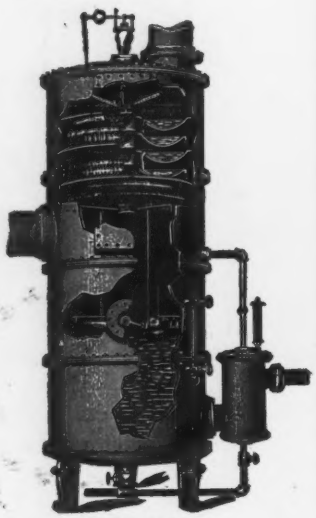

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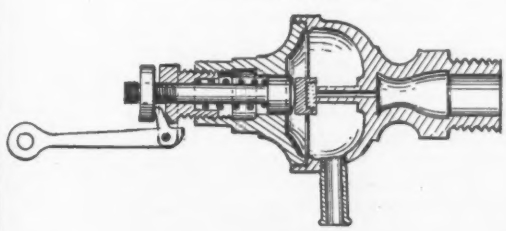

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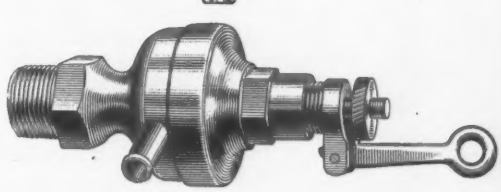

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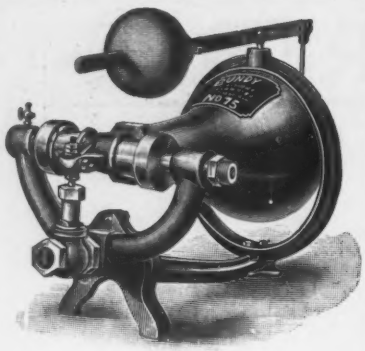

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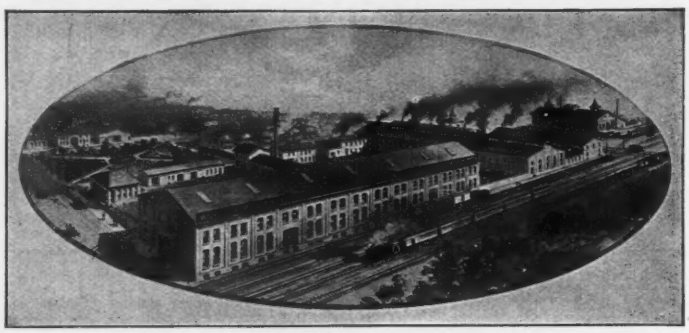

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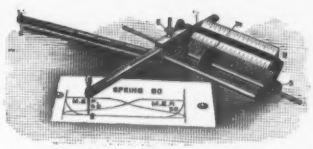

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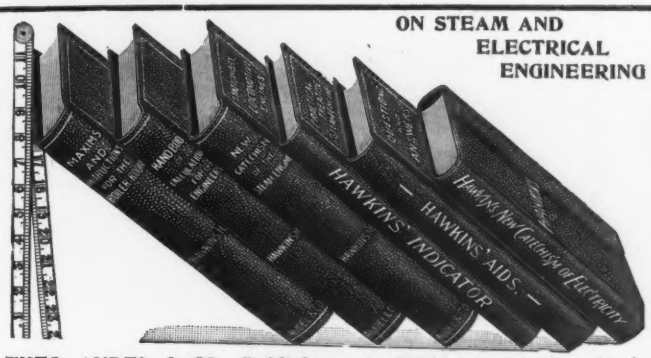

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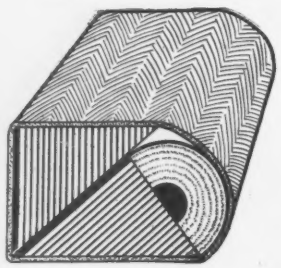

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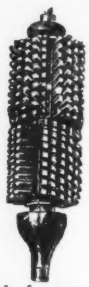
Showing Construction of Brush



Brush ready for use

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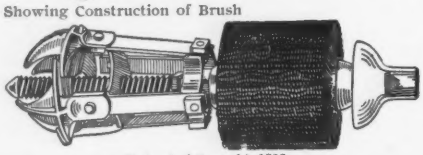
Pilley Expansion Flue Brush

It Is Guaranteed Not to Break, Being made of Malleable Iron and Tempered Steel

It Cleans the Entire Flue Every Time it is Pushed Through



Patented June 14, 1892

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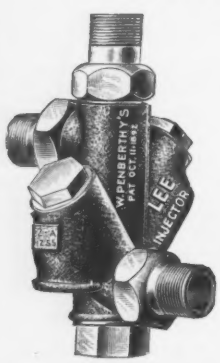

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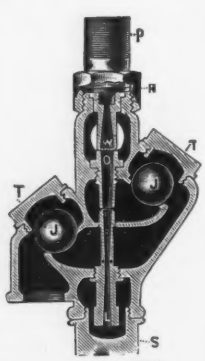

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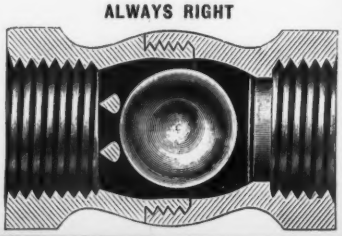

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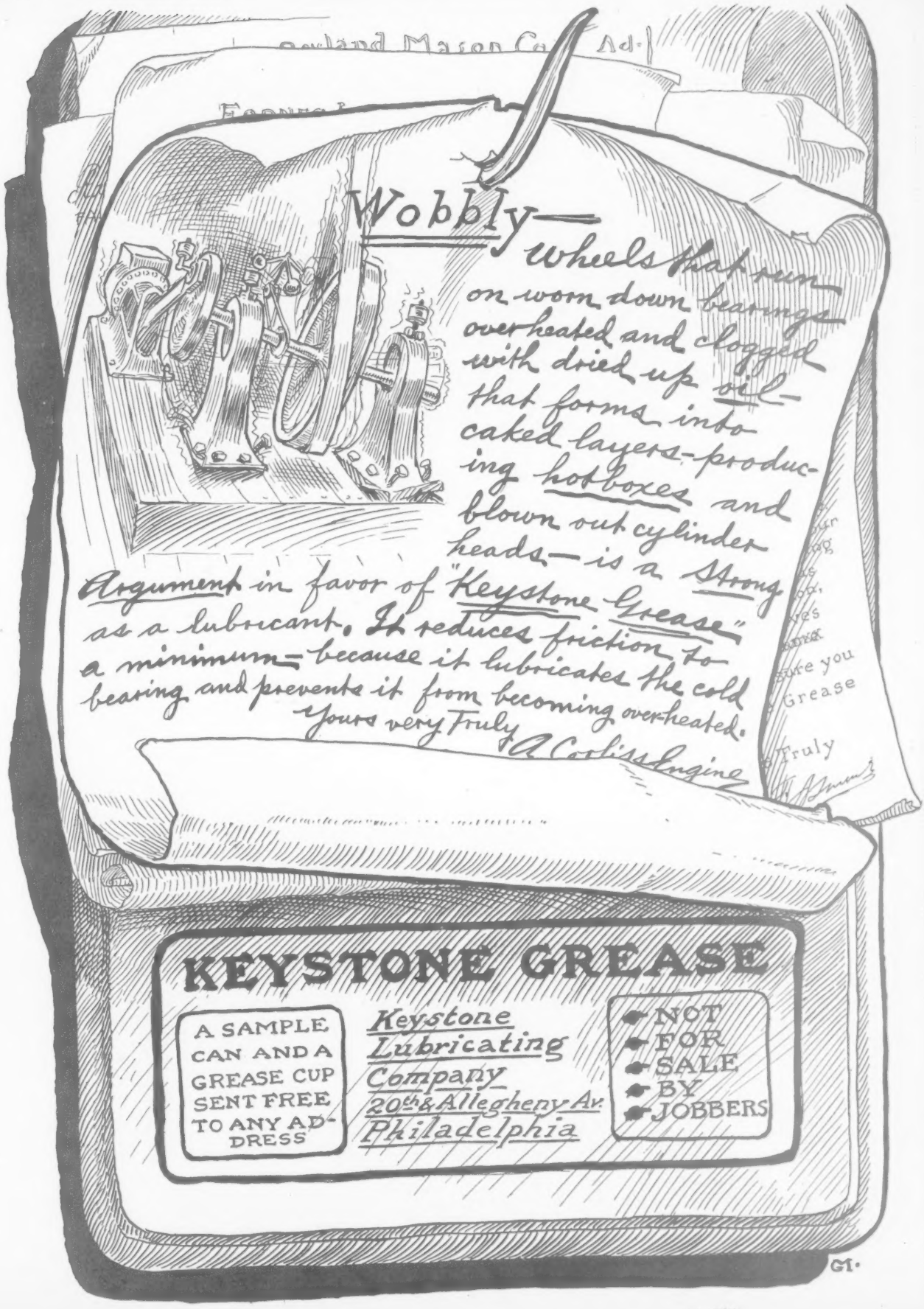
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Let every engineer make his own indicator book as he proceeds in his study and practice, and it will prove invaluable in after years. The present work has been compiled in this way, from data continually obtained during the author's professional career, extending over a third of a century.

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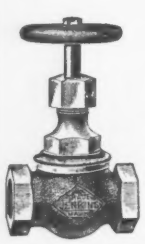

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